

Daily report

09-05-2020

## Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

## Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓  $\alpha$ : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓  $K$ : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to datapoints. We also discuss a specific issue every day.

Martí Català  
Pere-Joan Cardona, PhD  
*Comparative Medicine and Bioimage Centre of  
Catalonia; Institute for Health Science Research  
Germans Trias i Pujol*

Clara Prats, PhD  
Sergio Alonso, PhD  
Enric Álvarez, PhD  
Miquel Marchena  
David Conesa  
Daniel López, PhD  
*Computational Biology and Complex Systems;  
Universitat Politècnica de Catalunya - BarcelonaTech*

**With the collaboration of:** Guillem Álvarez, Oriol Bertomeu, Laura Dot, Lavínia Hrisu, Helena Kirchner, Daniel Molinuevo, Pablo Palacios, Sergi Pradas, David Rovira, Xavier Simó, Tomás Urdiales

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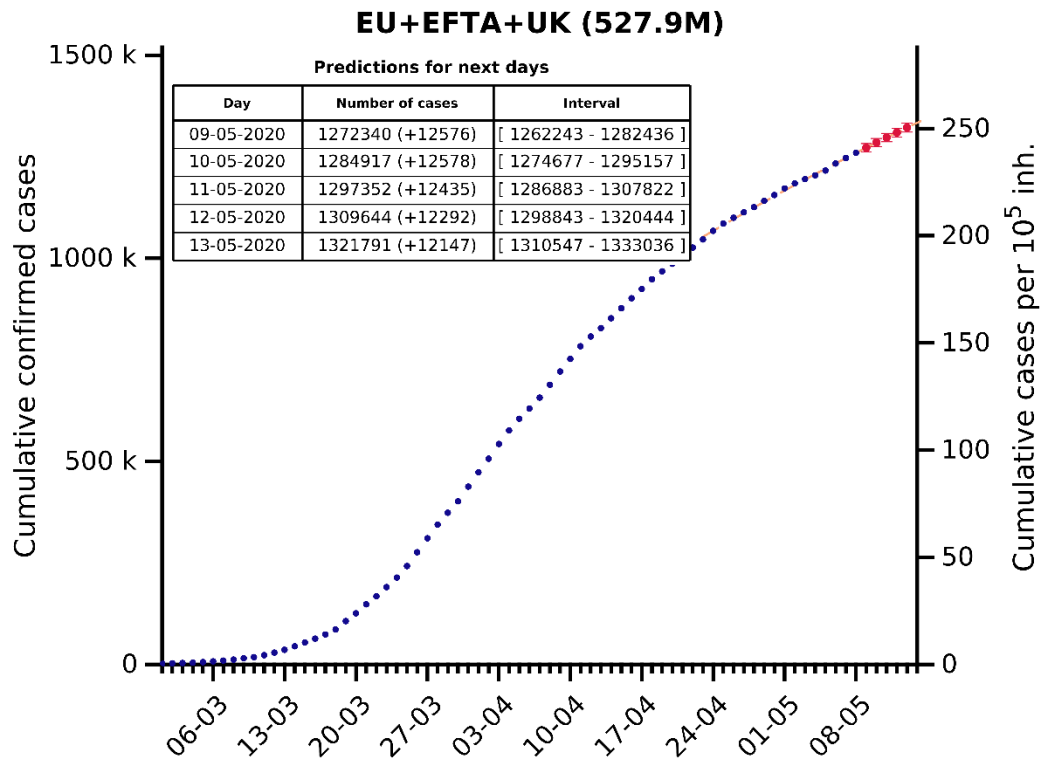


## **(0) Executive summary – Dashboard**

## Weekend short version

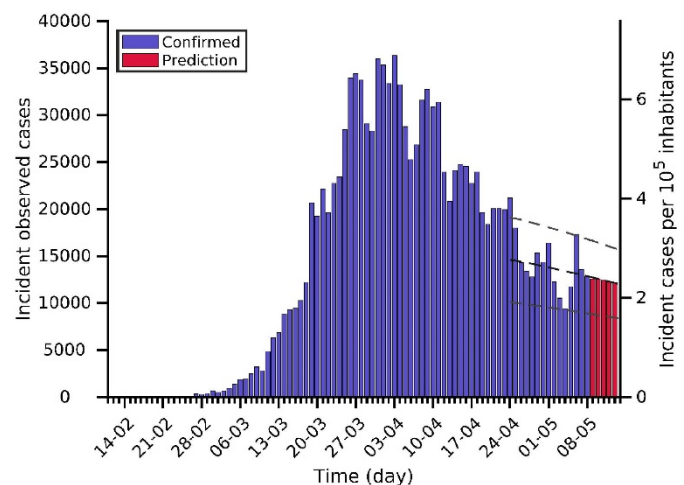
### Attack rate and short-term predictions in EU+EFTA+UK

Short-term predictions, based on last 15 points with increased weight on last 3:



### Highlights and/or warnings

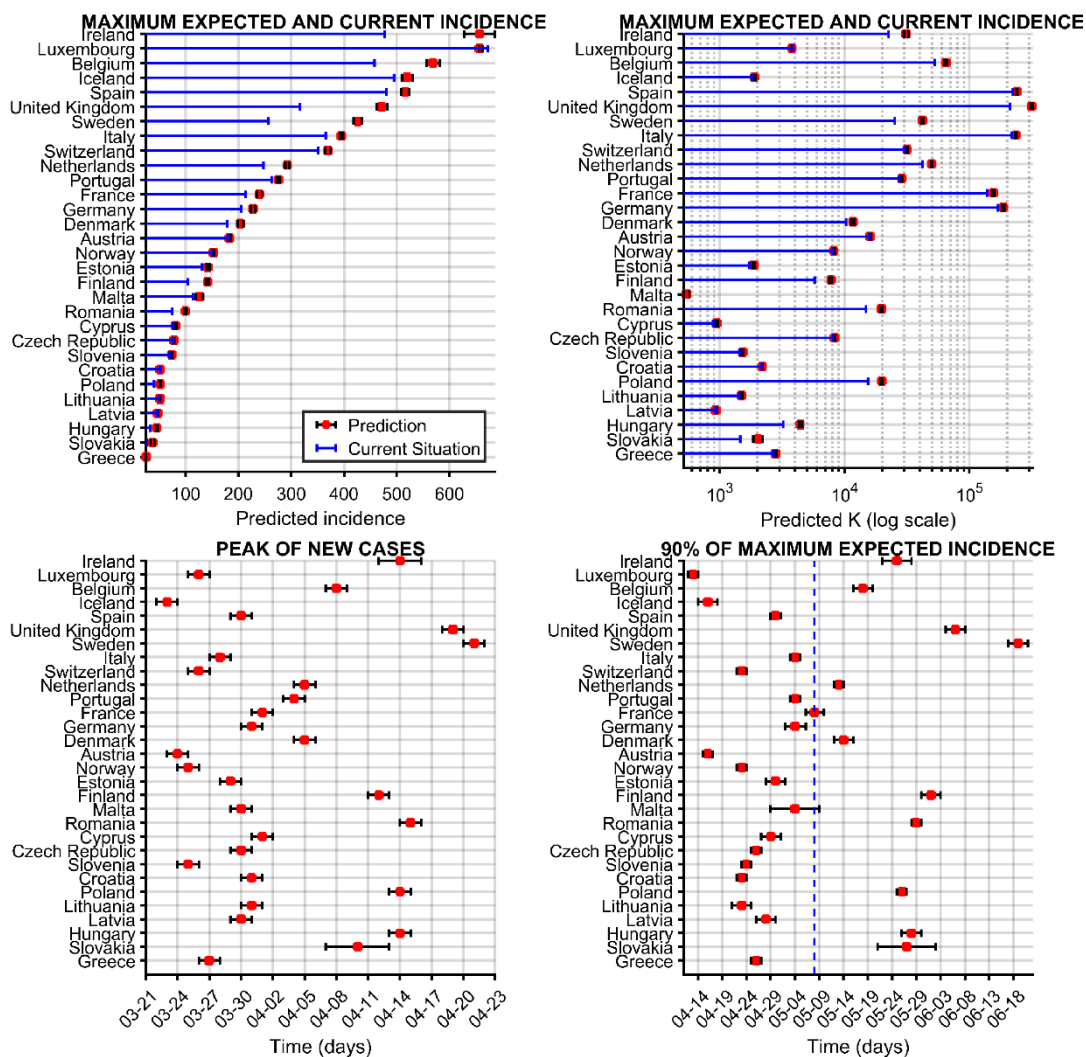
- New cases data confirm the trend of last days that situates it at the level of 12,000 daily (figure in the right).
- United Kingdom maintains its compromised situation.
- Belgium shows a significant increase in new cases for second consecutive day.
- High  $\rho_7$  shown by France is not indicative, as it is masked by the sudden rise in cases of two days ago.



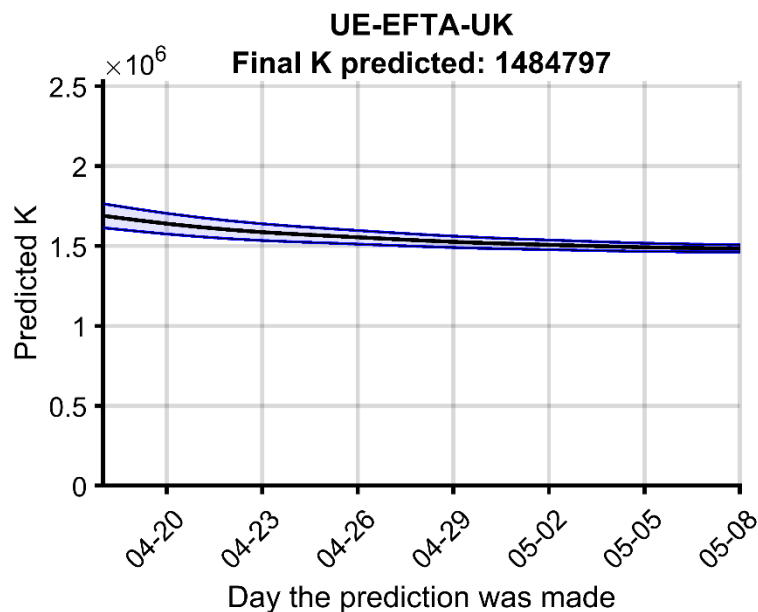
### Long-term predictions

**Long-term predictions**, evaluated with the **whole historical series**. See figure in the next page. Up-left: Predictions of maximum incidences per country (total final expected attack rate per  $10^5$  inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current

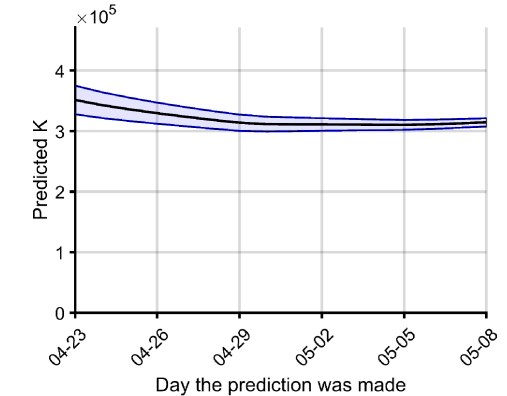
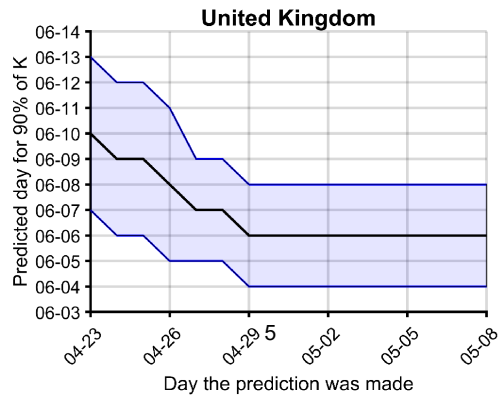
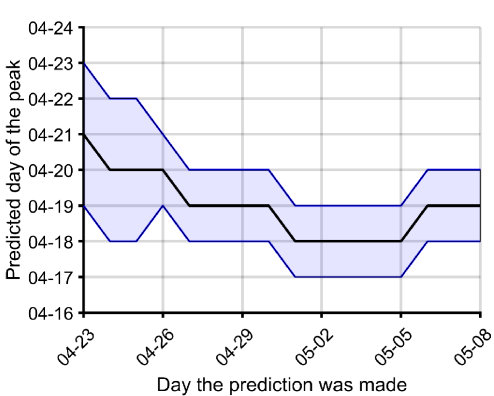
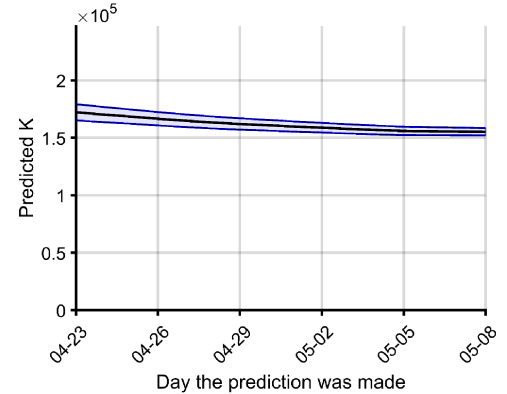
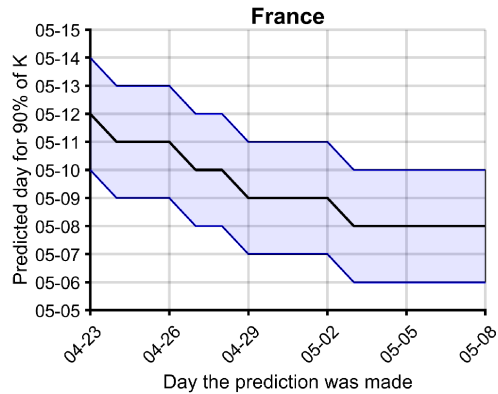
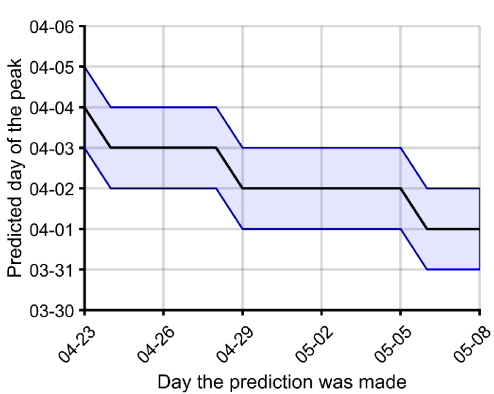
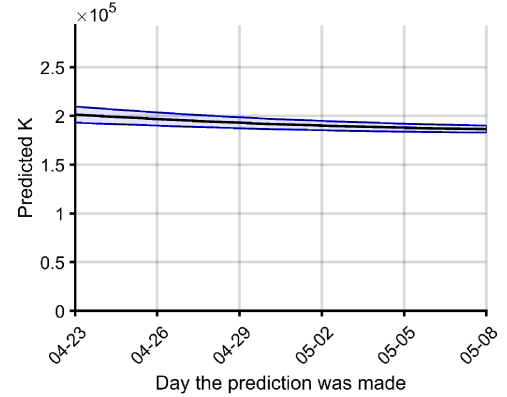
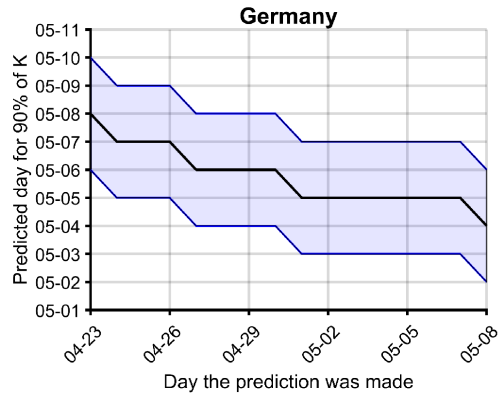
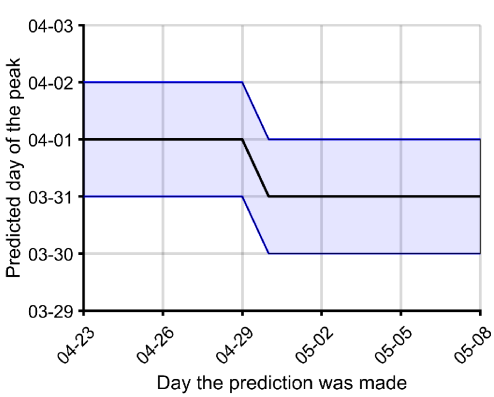
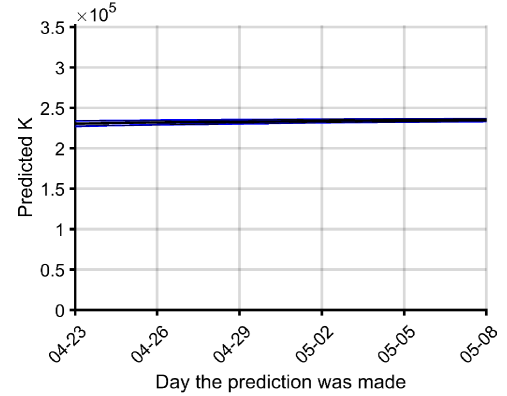
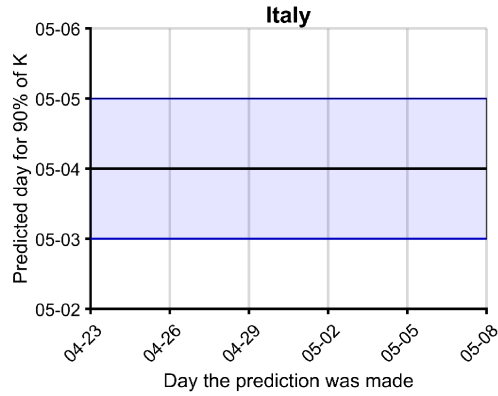
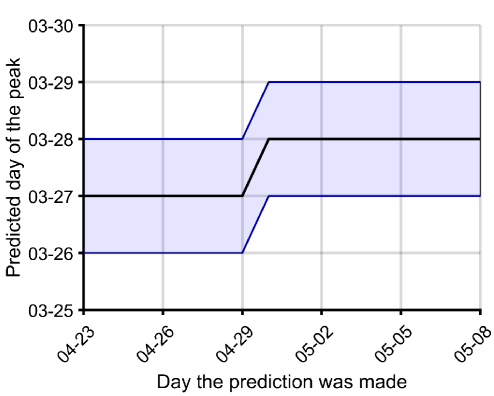
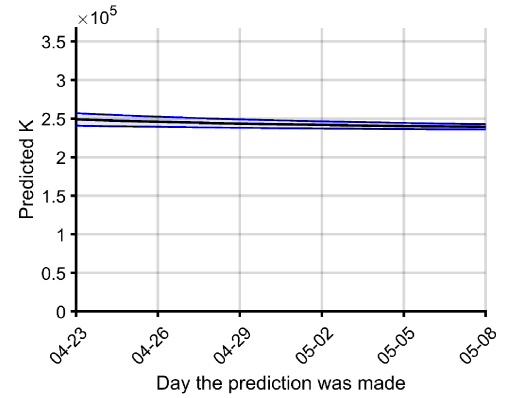
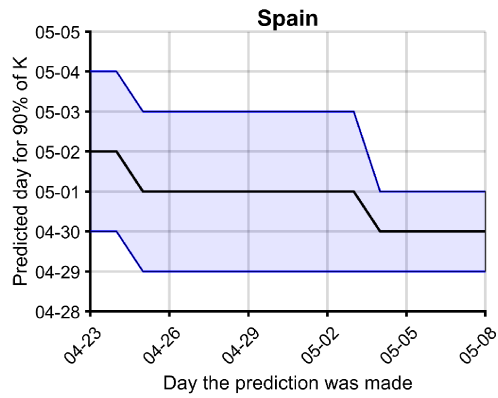
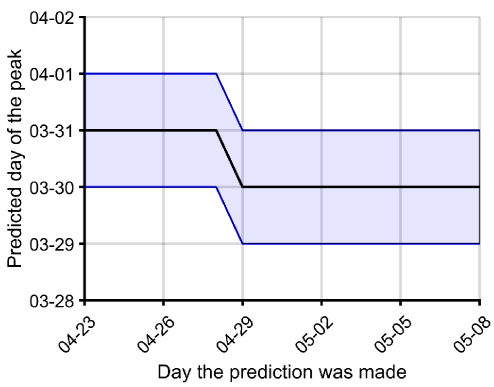
situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.



**Final expected K for UE+EFTA+UK.** Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown.

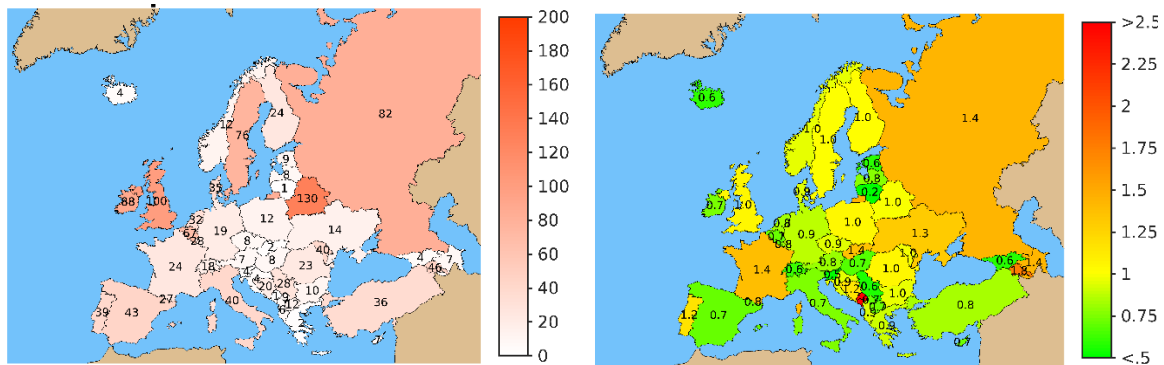


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## Situation and trends per country

**Maps.** The map in the left shows cumulative incidence last 14 days (A14). The map in the right shows smoothed spreading rate per country ( $\rho_7$ ).



**Table** of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables.  $EPG_{REP}$  and  $EPG_{EST}$  **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 <sup>5</sup> inh.	Cumulative deaths	Mortality /10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate /10 <sup>5</sup> inh.	$\rho_7^{(1)}$	$EPG_{REP}^{(2)}$	$EPG_{EST}^{(3)}$
Spain	222,857	480.8	26,299	56.7	20,327	43.9	0.70	31	366
Italy	217,185	365.4	30,201	50.8	24,191	40.7	0.75	30	430
United Kingdom	211,364	318.1	31,241	47.0	67,900	102.2	1.05	107	1,715
Germany	168,551	205.8	7,369	9.0	16,113	19.7	0.87	17	81
France	138,421	213.9	26,230	40.5	15,844	24.5	1.38	34	682
Belgium	52,011	457.9	8,521	75.0	7,718	68.0	0.70	48	831
Netherlands	42,093	247.8	5,359	31.5	5,558	32.7	0.82	27	352
Switzerland	30,124	351.5	1,525	17.8	1,529	17.8	0.61	11	56
Portugal	27,268	262.9	1,114	10.7	3,997	38.5	1.17	45	209
Sweden	25,265	256.8	3,175	32.3	7,698	78.2	1.00	78	1,164
Ireland	22,541	477.0	1,429	30.2	4,357	92.2	0.74	68	460
Austria	15,735	180.6	614	7.0	667	7.7	0.80	6	24
Poland	15,366	40.2	776	2.0	4,474	11.7	1.04	12	74
Romania	14,811	74.9	898	4.5	4,394	22.2	1.05	23	169
Denmark	10,218	178.9	522	9.1	2,008	35.2	0.94	33	176
Czech Republic	8,077	76.1	273	2.6	804	7.6	0.94	7	26
Norway	8,034	149.7	213	4.0	626	11.7	0.95	11	31
Finland	5,738	104.3	260	4.7	1,343	24.4	1.01	25	131
Luxembourg	3,871	672.0	100	17.4	176	30.6	0.80	24	NA
Hungary	3,213	32.9	405	4.2	770	7.9	0.66	5	75
Greece	2,691	24.1	150	1.3	201	1.8	0.90	2	10
Croatia	2,161	51.3	86	2.0	152	3.6	0.95	3	NA
Bulgaria	1,911	26.8	88	1.2	723	10.1	0.96	10	NA
Iceland	1,801	494.4	10	2.7	12	3.3	0.59	2	NA
Estonia	1,725	131.5	56	4.3	120	9.1	0.58	5	NA
Slovakia	1,455	26.7	26	0.5	95	1.7	1.37	2	NA
Slovenia	1,450	69.8	100	4.8	77	3.7	0.45	2	NA
Lithuania	1,436	49.4	49	1.7	26	0.9	0.17	0	NA
Latvia	928	47.1	18	0.9	144	7.3	0.77	6	NA
Cyprus	891	76.2	21	1.8	87	7.4	0.71	5	NA
Malta	489	114.0	5	1.2	42	9.8	NA	NA	NA
Liechtenstein	83	215.3	1	2.6	1	2.6	NA	NA	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2.0	200	2000
Best	Best	Best	Best	Best	Best	0.0	0	0

<sup>(1)</sup>  $\rho_7$  is the average of 7 consecutive  $\rho$ , but can still fluctuate. <sup>(2)</sup> EPG stands for Effective Growth Potential.  $EPG_{REP}$  is obtained by multiplying attack rate of last 14 days per 10<sup>5</sup> inhabitants (i.e. density of cases) by  $\rho_7$  (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days).  $EPG_{EST}$  is obtained by multiplying estimated real attack rate of last 14 days per 10<sup>5</sup> inhabitants by  $\rho_7$ .

## Time indicators by country

This table summarizes a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of  $1/10^5$  inhabitants and an attack rate of  $10/10^5$  inhabitants, and time interval between attack rates of 10 to 100 per  $10^5$  inhabitants (only for countries that have overtaken this threshold).

Countries	Days since the first 50 cases	Time interval between 1 and 10 cases / 105 inh. (days)	Time interval between 10 and 100 cases / 105 inh. (days)
Italy	77	11	16
France	71	10	20
Germany	71	12	17
Spain	69	7	12
United Kingdom	67	11	19
Norway	66	9	24
Switzerland	66	9	12
Netherlands	65	11	20
Sweden	65	10	28
Austria	64	10	14
Belgium	64	11	14
Greece	63	18	NA
Iceland	63	5	15
Denmark	61	4	30
Czech Republic	60	11	NA
Finland	59	12	46
Portugal	59	9	15
Slovenia	59	6	NA
Ireland	58	8	18
Romania	58	15	NA
Estonia	57	5	30
Poland	57	17	NA
Bulgaria	55	30	NA
Luxembourg	55	6	7
Slovakia	55	24	NA
Croatia	54	12	NA
Latvia	53	12	NA
Cyprus	52	12	NA
Hungary	52	20	NA
Malta	51	8	34
Lithuania	50	9	NA
Liechtenstein	45	9	11

## Situation, trends and long-term predictions in Italian and Spanish regions

### Italy

Country	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 <sup>5</sup> inh.	Cumulative deaths	Mortality / 10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate / 10 <sup>5</sup> inh.	$\rho_7^{(1)}$	EPG <sub>REP</sub> <sup>(2)</sup>	EPG <sub>EST</sub> <sup>(3)</sup>
Lombardia	81.225	808,9	14.924	148,6	9.256	92,2	0,92	85	1.603
Piemonte	28.549	655,3	3.331	76,5	4.123	94,6	0,64	61	744
Emilia Romagna	26.719	599,2	3.827	85,8	2.510	56,3	0,61	34	500
Veneto	18.671	380,6	1.643	33,5	1.280	26,1	0,65	17	161
Toscana	9.745	261,3	937	25,1	730	19,6	0,64	12	126
Liguria	8.738	563,5	1.276	82,3	1.437	92,7	0,63	58	861
Lazio	7.133	121,3	553	9,4	909	15,5	0,82	13	103
Marche	6.493	425,7	958	62,8	435	28,5	0,89	25	381
Campania	4.576	78,9	388	6,7	277	4,8	0,77	4	31
Trento	4.292	400,3	438	40,8	454	42,3	0,41	17	356
Puglia	4.286	106,4	443	11,0	374	9,3	0,89	8	89
Sicilia	3.313	66,3	256	5,1	293	5,9	0,59	3	28
Friuli Venezia Giulia	3.124	257,1	308	25,3	221	18,2	0,58	11	105
Abruzzo	3.086	235,3	355	27,1	254	19,4	1,03	20	236
Bolzano	2.567	2.389,3	290	269,9	91	84,7	0,71	60	150
Umbria	1.407	159,5	71	8,0	41	4,6	1,55	7	NA
Sardegna	1.334	81,4	119	7,3	63	3,8	0,98	4	36
Valle d'Aosta	1.152	917,2	139	110,7	52	41,4	0,53	22	260
Calabria	1.129	58,0	90	4,6	41	2,1	0,75	2	NA
Basilicata	382	67,9	27	4,8	21	3,7	NA	NA	NA
Molise	347	113,5	22	7,2	55	18,0	7,90	142	NA

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200
Best	Best	Best	Best	Best	Best	Best	0,0	0

### Spain

Autonomous regions	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 <sup>5</sup> inh.	Cumulative deaths	Mortality rate / 10 <sup>5</sup> inh.	Active cases (last 14 days)	14-day attack rate / 10 <sup>5</sup> inh.	$\rho_7^{(1)}$	EPG <sub>REP</sub> <sup>(2)</sup>	EPG <sub>EST</sub> <sup>(3)</sup>
Madrid	64,523	971.6	8,598	129.5	5,704	85.9	0.99	85	1,187
Catalunya	51,935	686.5	5,507	72.8	5,674	75.0	0.7	54	583
Castilla y Leon	17,807	739.5	1,885	78.3	1,817	75.5	0.67	51	556
Castilla-La Mancha	16,278	799.7	2,738	134.5	769	37.8	0.80	30	534
Euskadi	13,111	602.0	1,403	64.4	745	34.2	0.62	21	267
Andalucía	12,298	145.9	1,317	15.6	595	7.1	0.55	4	45
Comunitat Valenciana	10,661	214.3	1,315	26.4	595	12.0	0.95	11	146
Galicia	9,216	341.3	591	21.9	672	24.9	1.24	31	210
Aragon	5,291	400.6	823	62.3	369	27.9	0.78	22	359
Navarra	5,039	775.3	487	74.9	412	63.4	0.77	49	473
La Rioja	4,000	1,275.6	344	109.7	179	57.1	0.67	38	326
Extremadura	2,907	272.9	477	44.8	189	17.7	0.95	17	276
Asturias	2,342	229.1	293	28.7	104	10.2	1.12	11	146
Canarias	2,250	101.9	148	6.7	95	4.3	0.69	3	21
Cantabria	2,241	385.3	201	34.6	170	29.2	0.51	15	141
Baleares	1,944	163.7	207	17.4	97	8.2	0.87	7	86
Murcia	1,506	101.2	138	9.3	38	2.6	0.94	2	22
Melilla	119	140.5	2	2.4	11	13.0	NA	NA	NaN
Ceuta	110	129.7	4	4.7	10	11.8	NA	NA	NaN

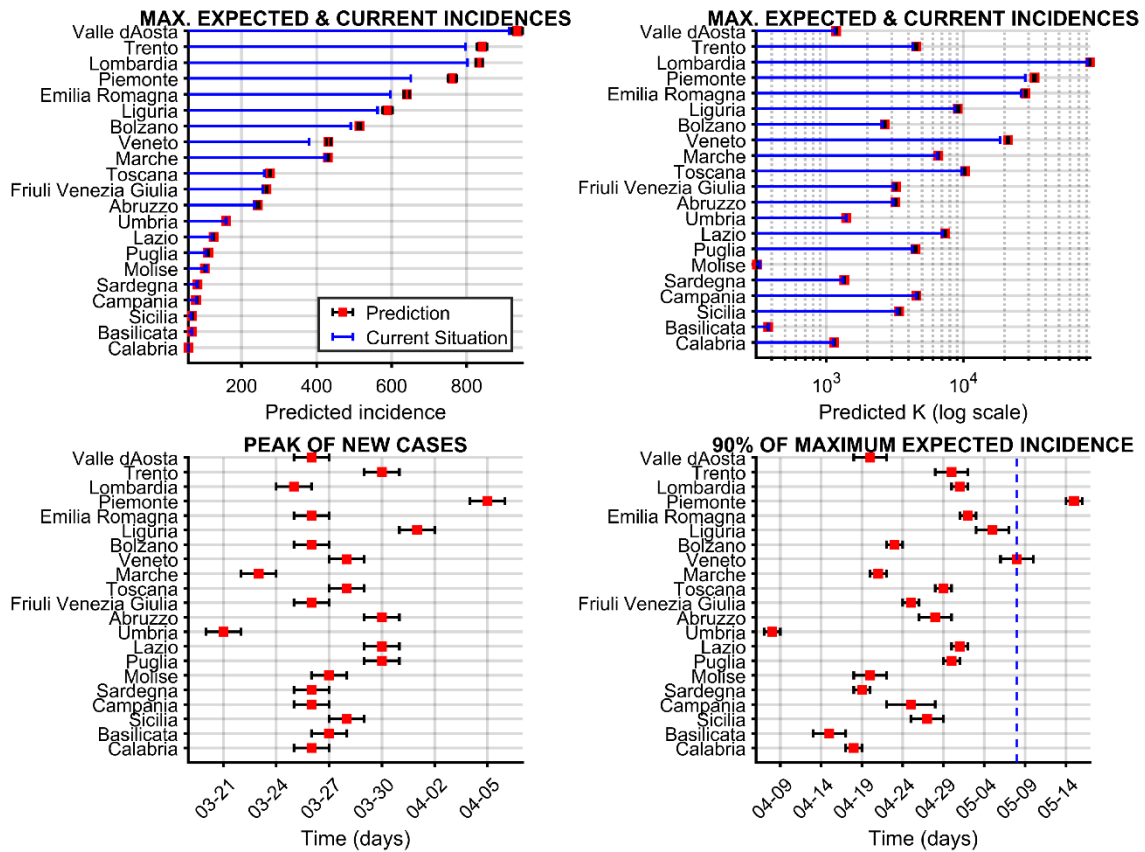
  

Scale								
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Best	Best	Best	Best	Best	Best	Best	0.0	0

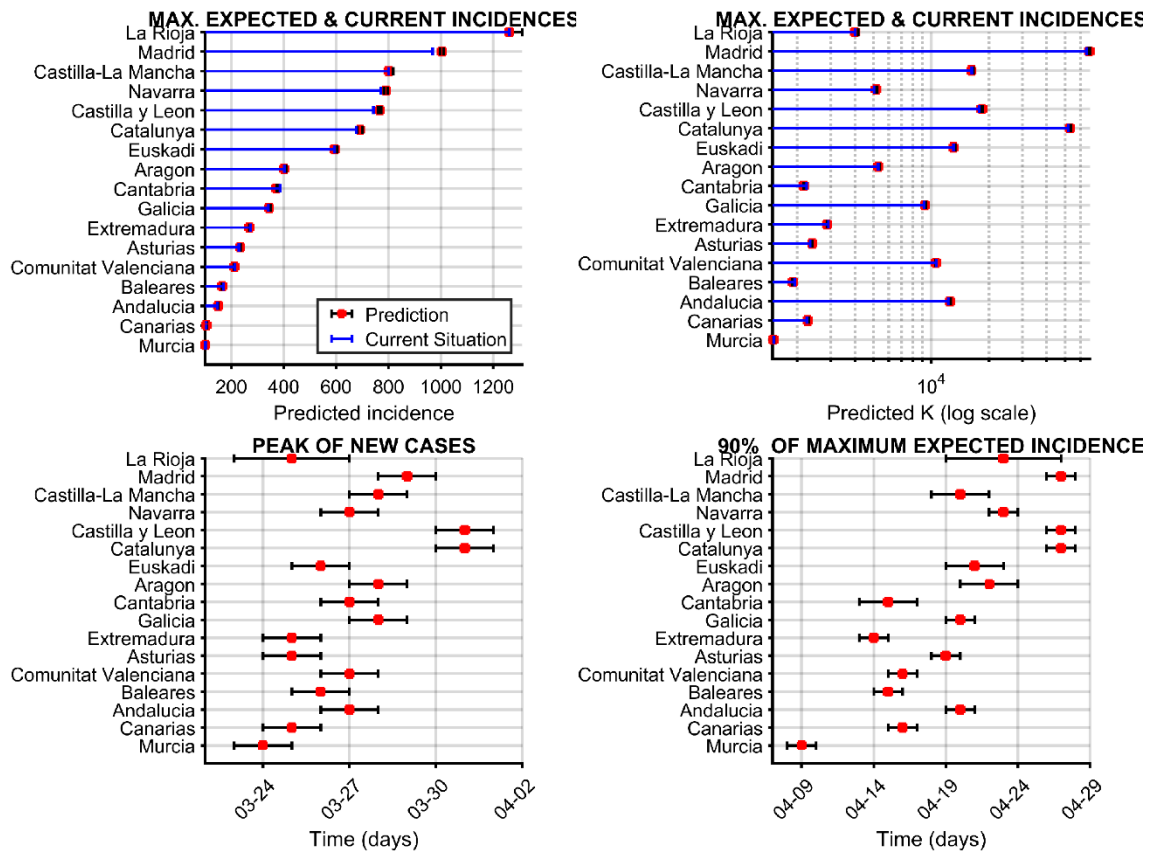
<sup>(1)</sup> Disclaimer: parameter  $\rho$  is very sensitive and experiments daily variations.  $\rho_7$  is the average of 7 consecutive  $\rho$ , but can still fluctuate. <sup>(2)</sup> EPG stands for Effective Growth Potential. EPG<sub>REP</sub> is obtained by multiplying attack rate of last 14 days per 10<sup>5</sup> inhabitants (i.e. density of cases) by  $\rho_7$  (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG<sub>EST</sub> is obtained by multiplying estimated real attack rate of last 14 days per 10<sup>5</sup> inhabitants by  $\rho_7$ .

**Long-term predictions.** These plots show long-term predictions of: new cases' peaks, final incidence value and approximate date when 90% of total final incidence will be reached. In all three cases we are dealing with the evaluation of global dynamics, which requires small changes in methodology: all data points be used instead of last 15 and with equal weight distribution among them. Blue dashed line indicates current timepoint. See details in Report from 11th April 2020.

## Italy

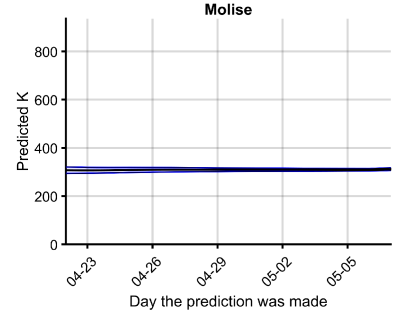
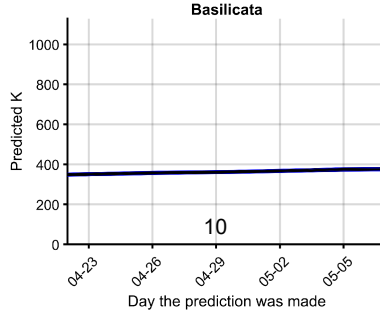
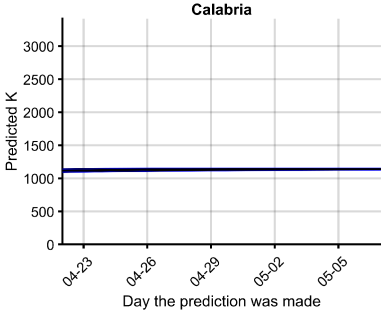
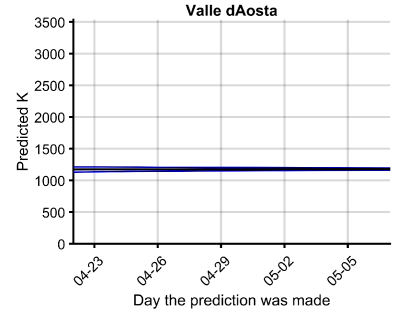
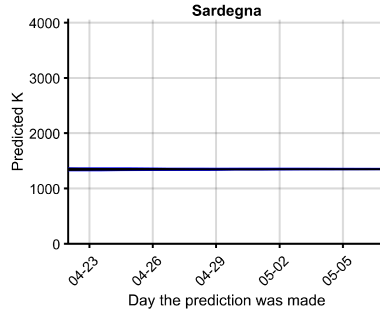
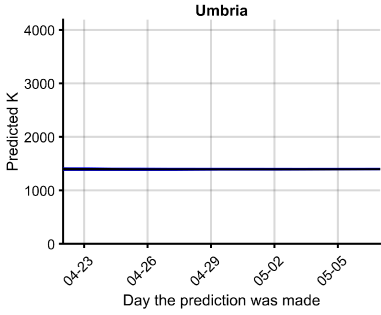
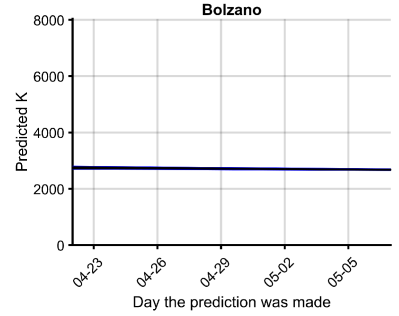
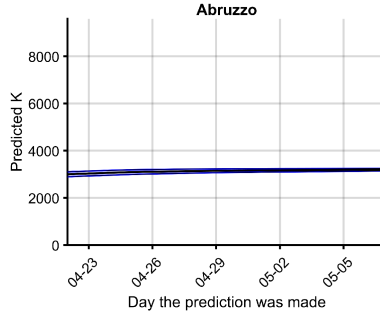
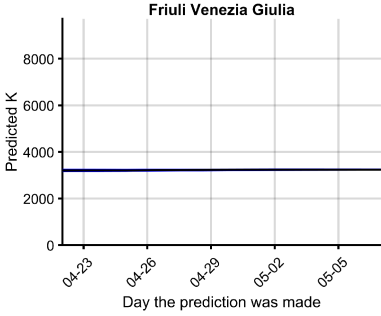
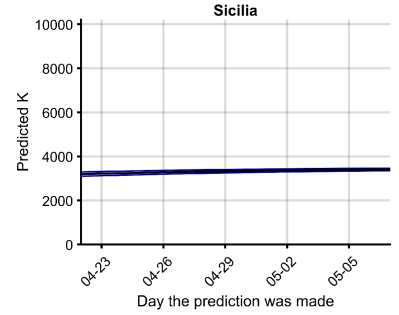
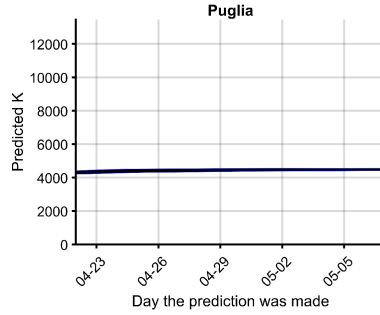
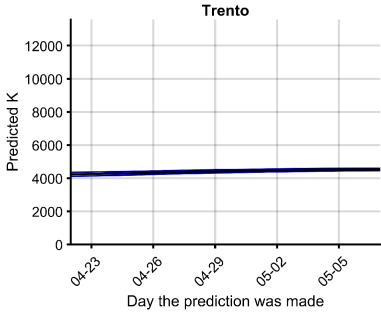
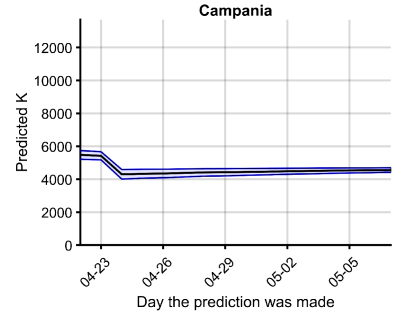
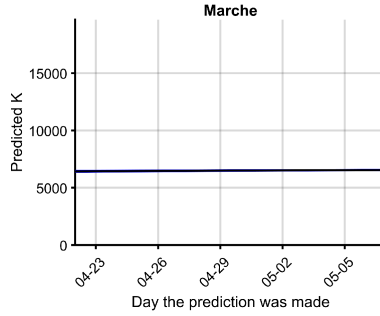
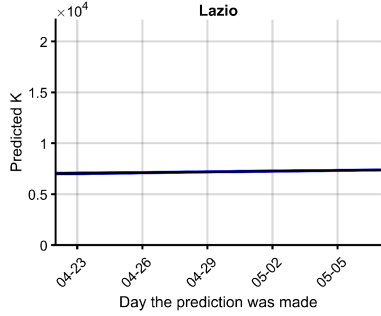
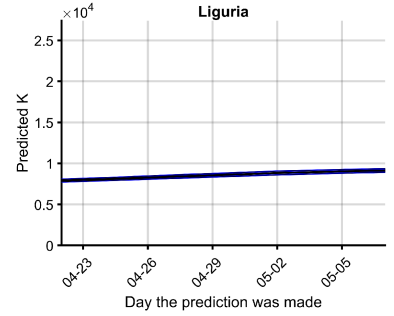
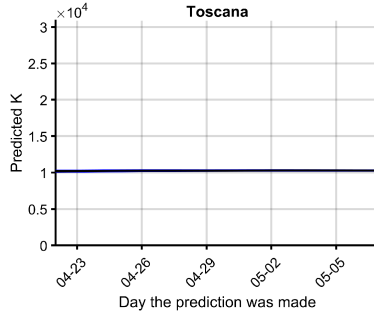
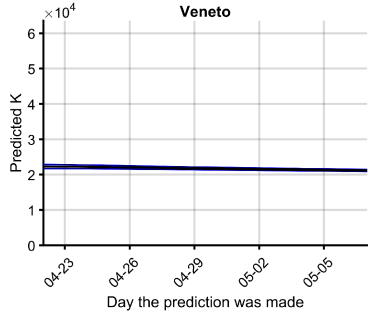
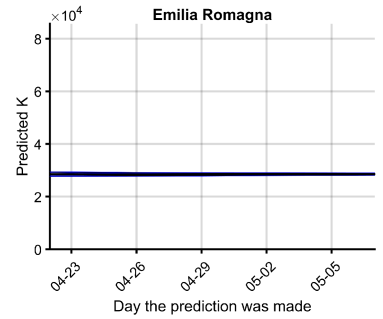
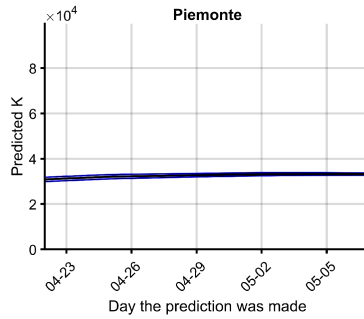
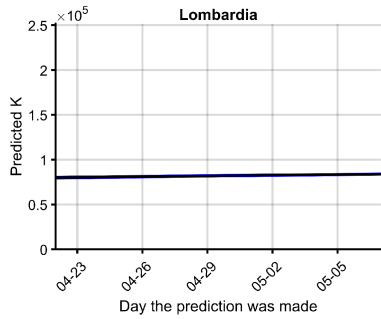


## Spain

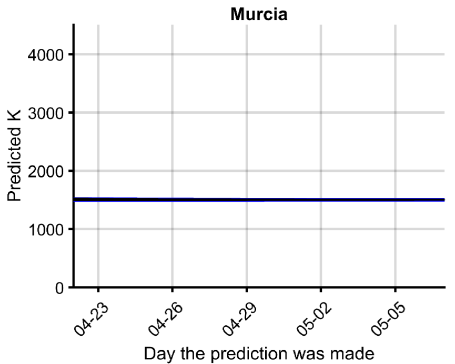
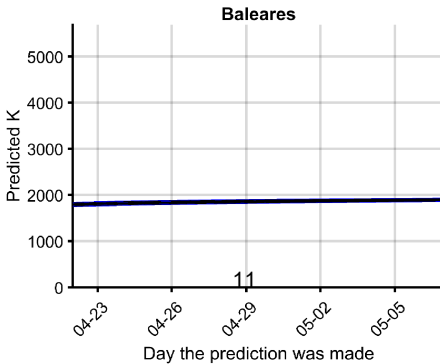
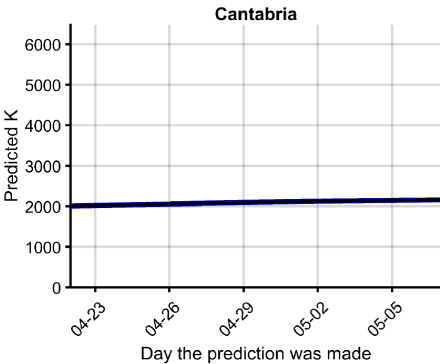
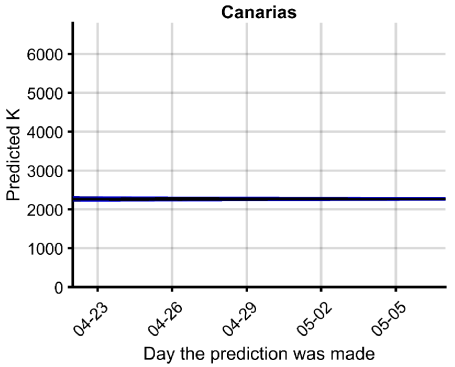
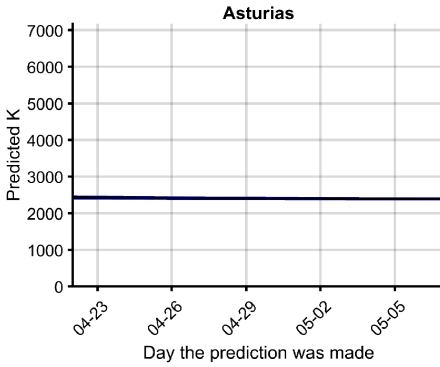
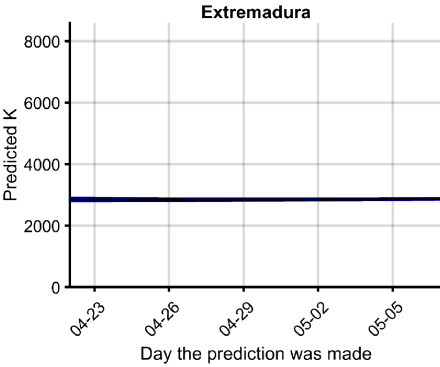
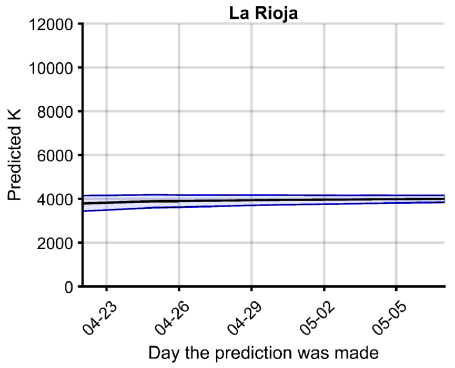
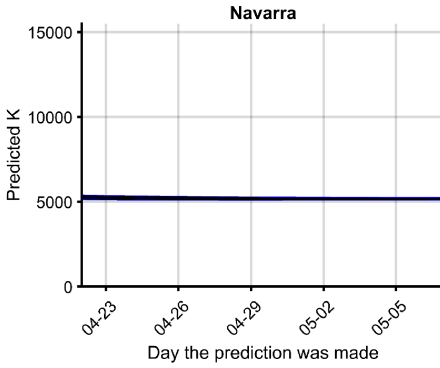
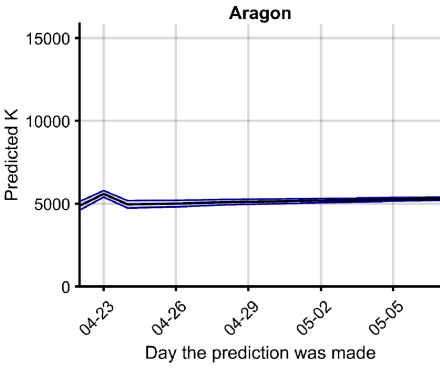
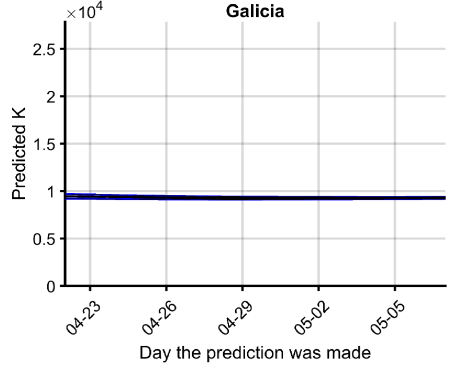
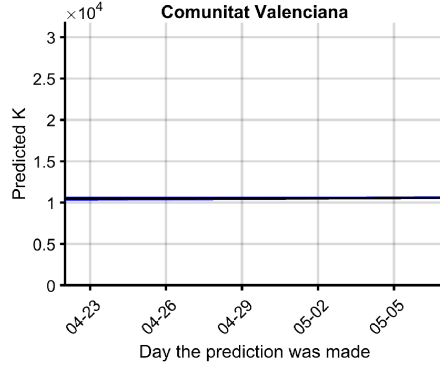
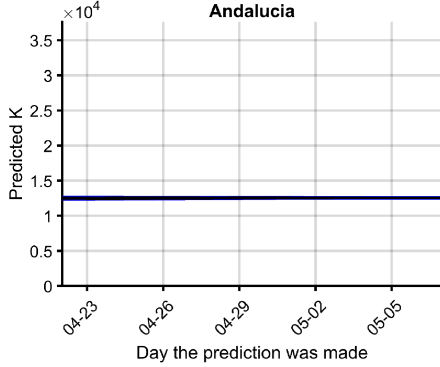
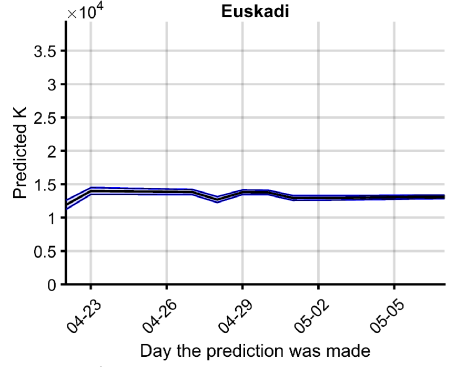
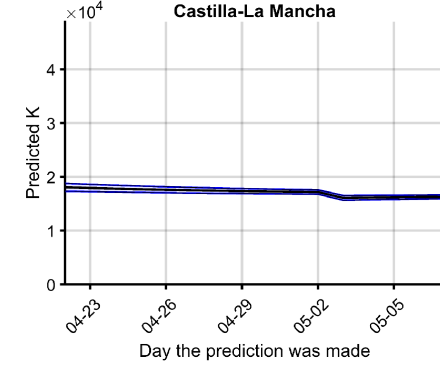
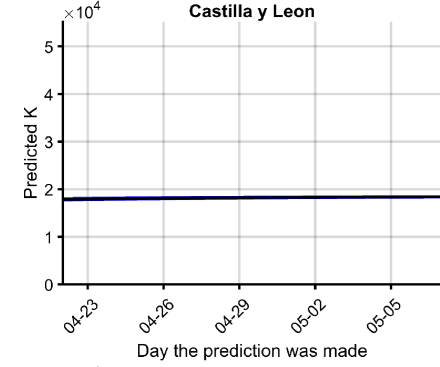
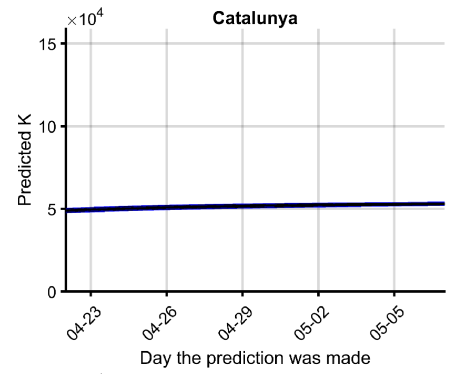
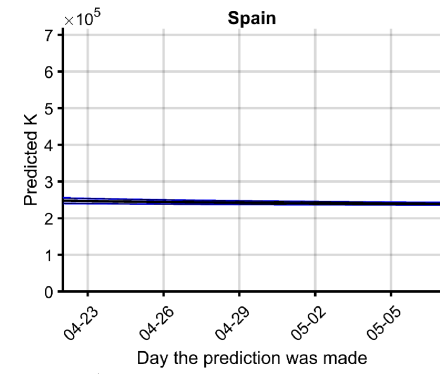




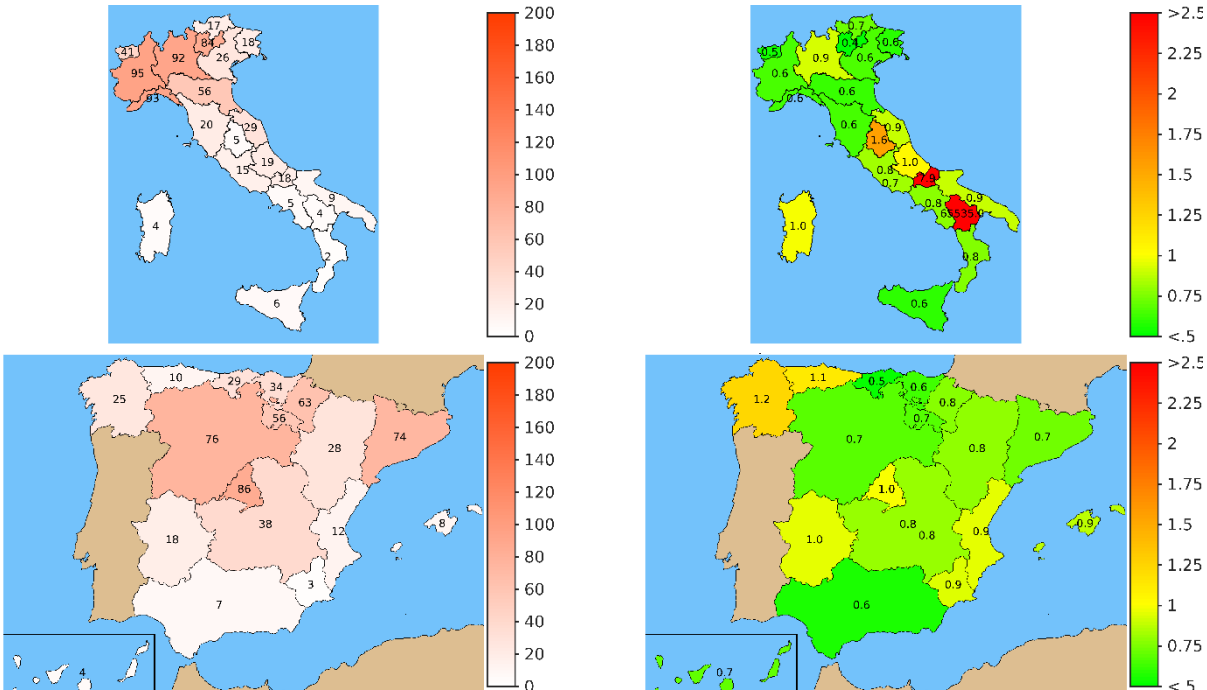
2020-05-08



2020-05-08



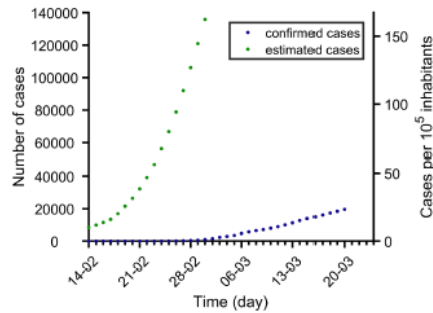
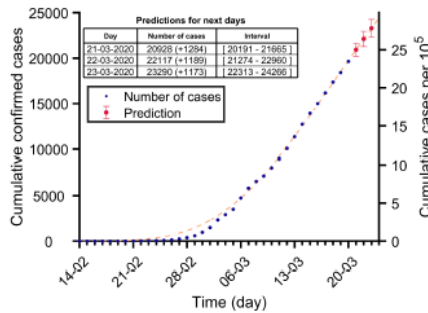
**Maps.** The maps in the left show cumulative incidence last 14 days ( $A_{14}$ ). The maps in the right show smoothed spreading rate per country ( $p_7$ ).



## Legend: Countries' reports details

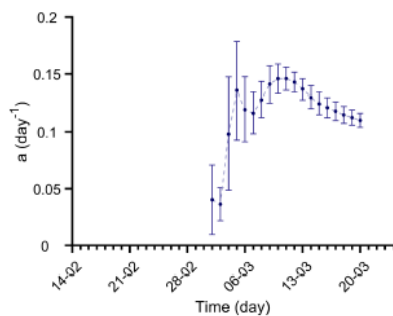
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence:  $23/10^5$

Confirmed cases:  
data (blue),  
model fitted  
(dashed line),  
predictions (red  
points and table)

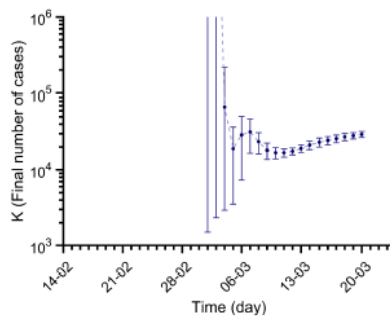


Estimated  
cases using  
death rate (see  
Methods)

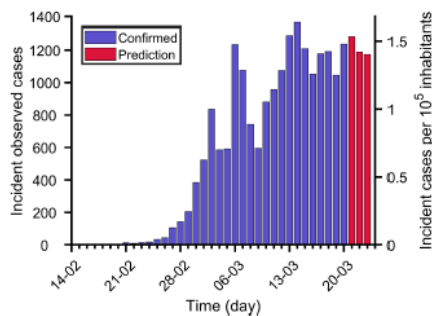
Fitted  $a$  value  
using points  
prior to each  
date



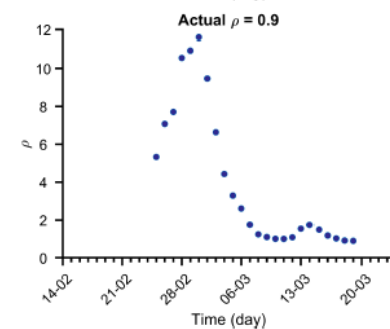
Fitted  $K$  value  
using points  
prior to each  
date



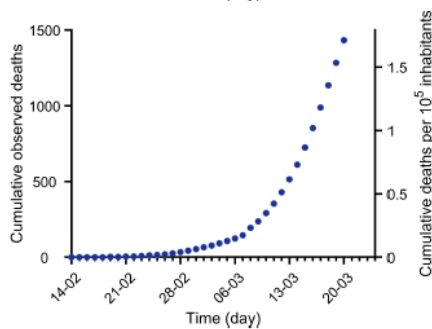
Reported  
and  
predicted  
new cases



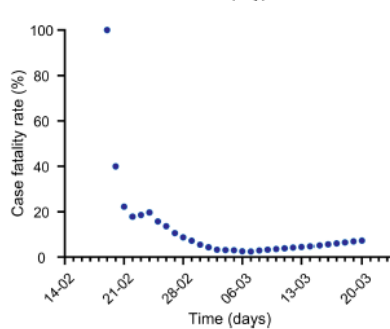
Evolution of  $\rho$ , a  
parameter related  
with Reproduction  
number (see  
Methods)



Reported  
deaths

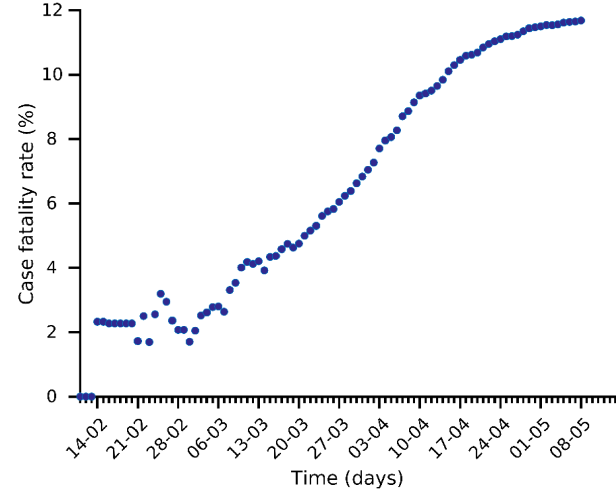
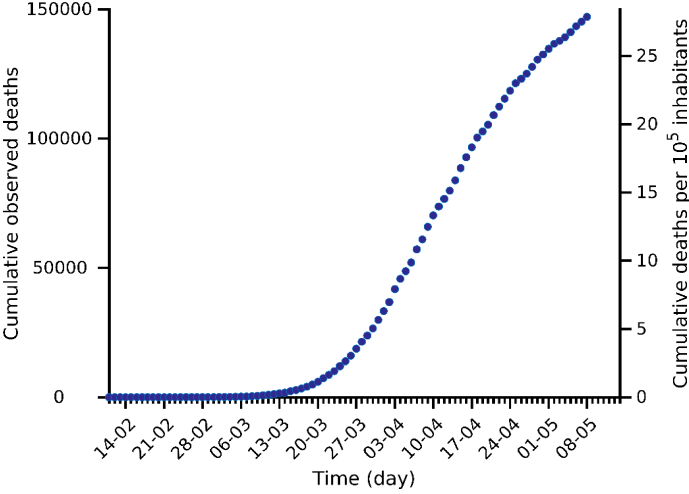
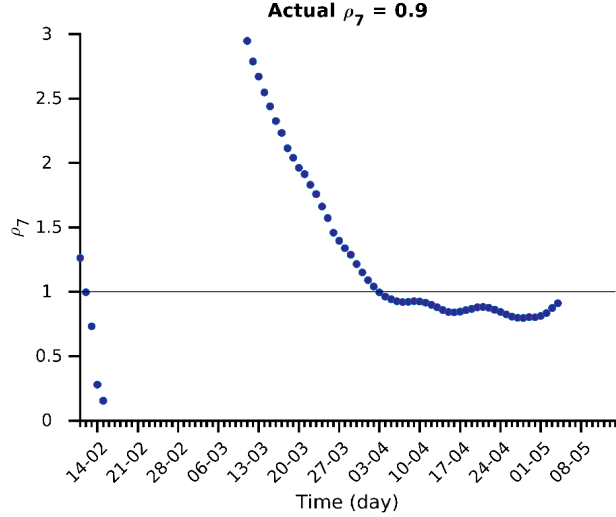
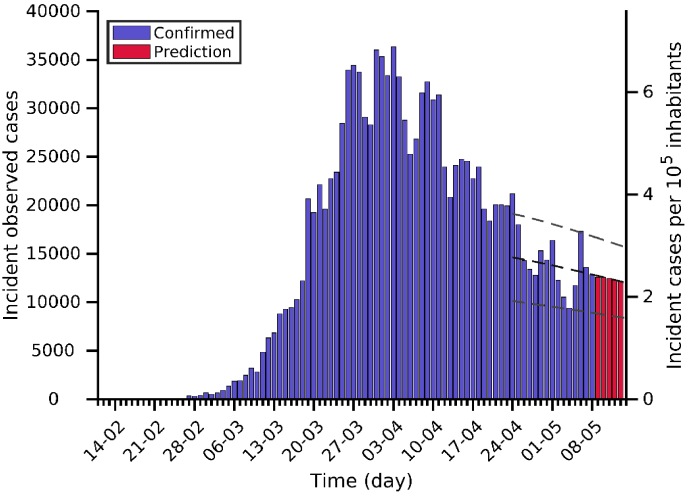
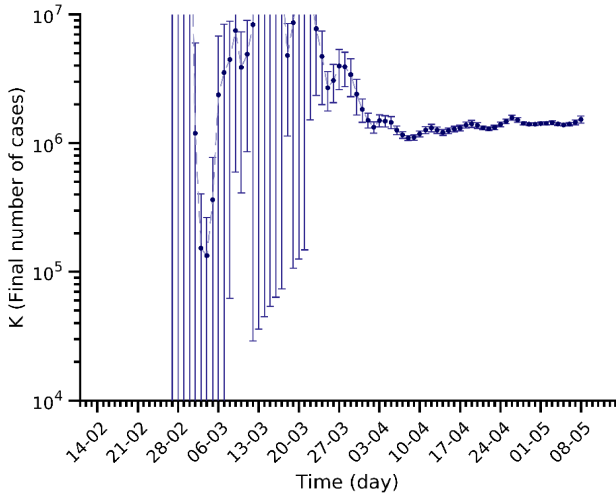
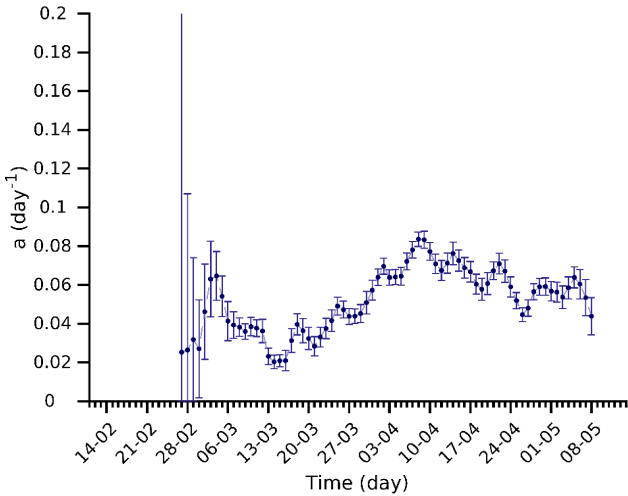
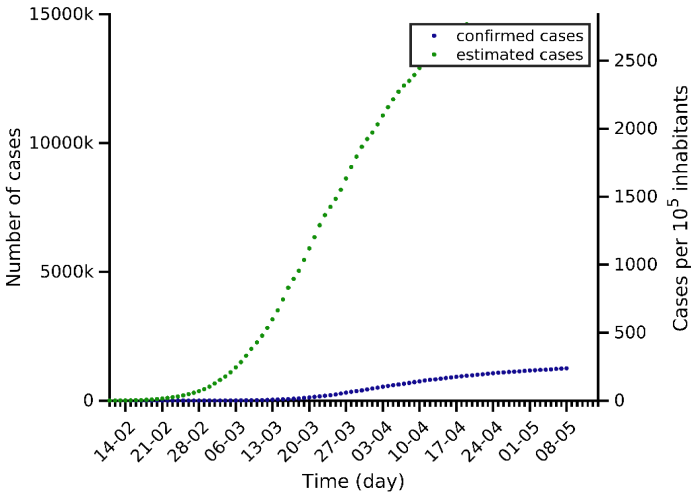
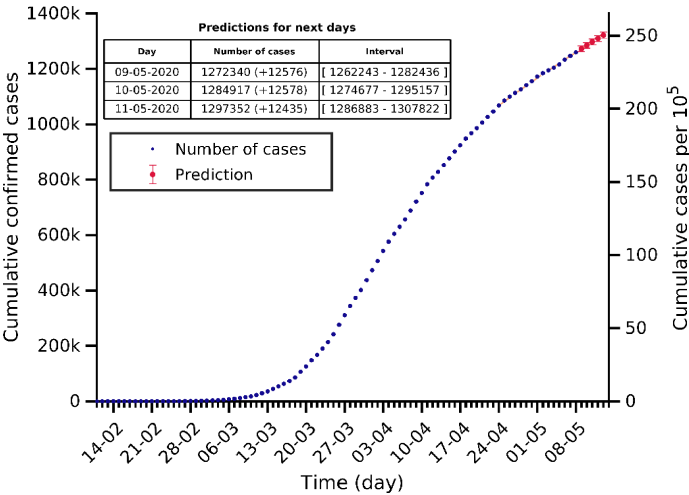


Deaths /  
cumulated  
reported cases

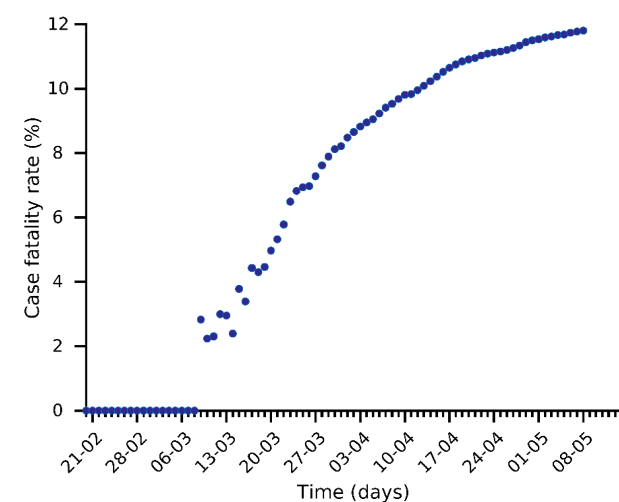
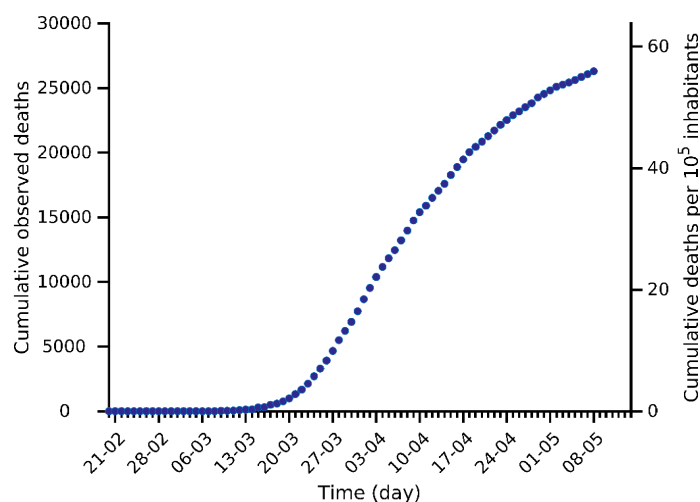
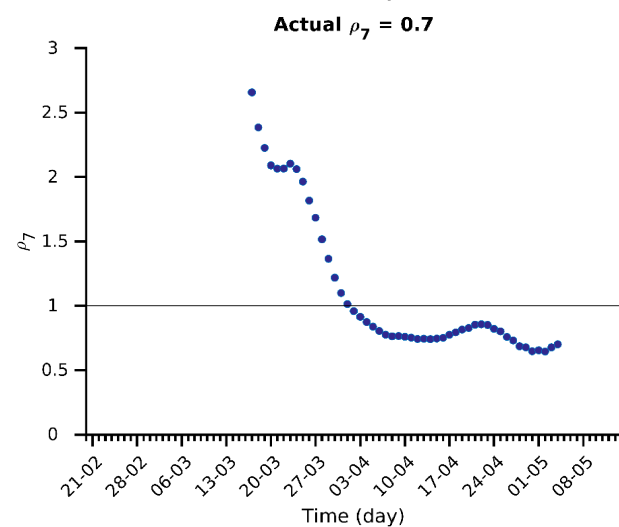
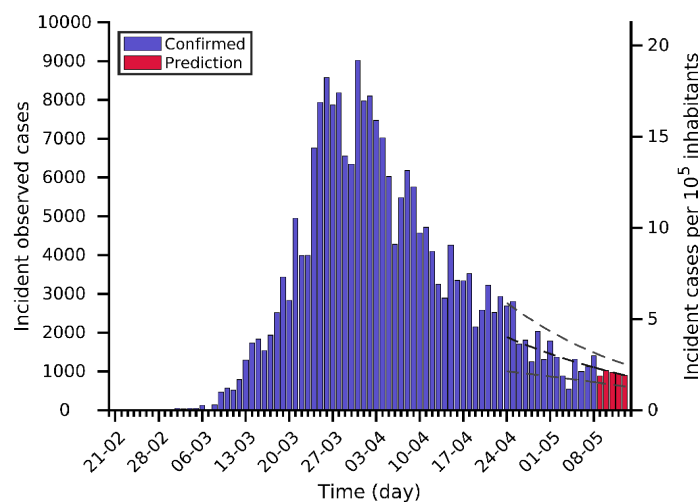
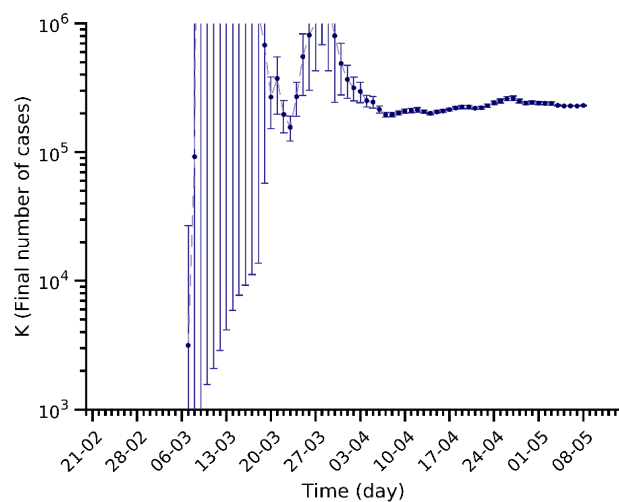
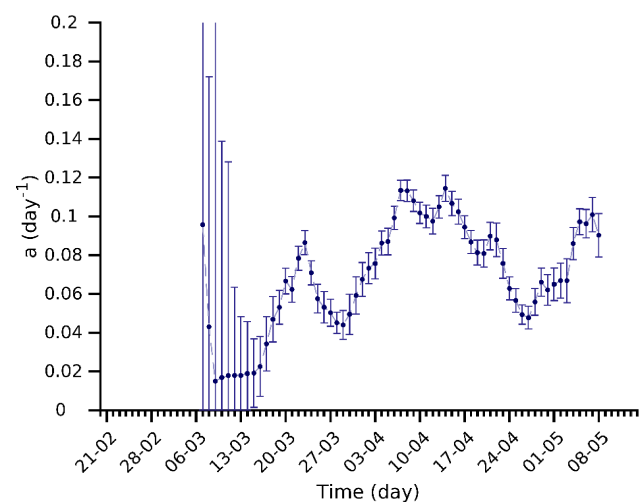
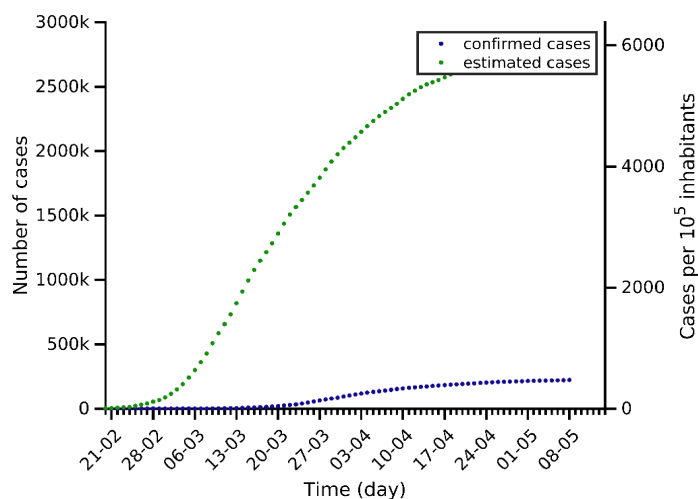
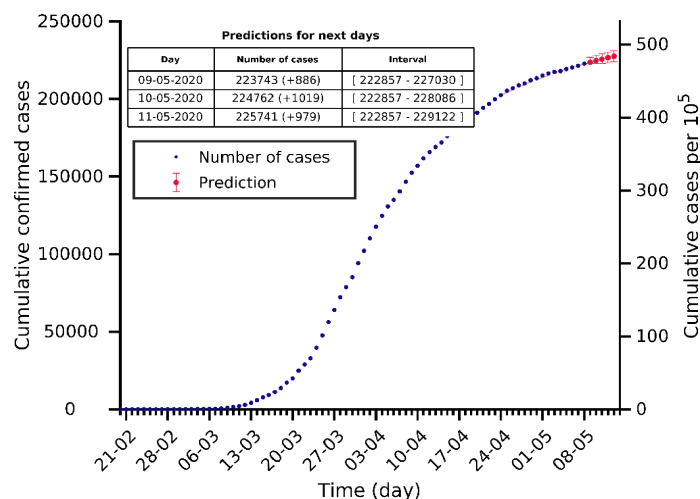


## **(1) Analysis and prediction of COVID-19 for EU+EFTA+UK**

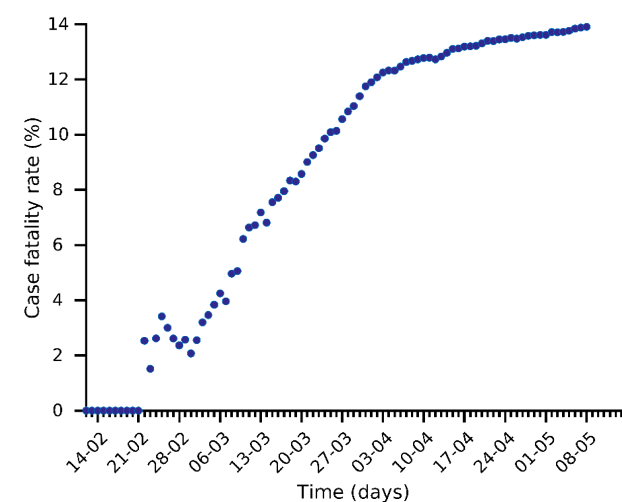
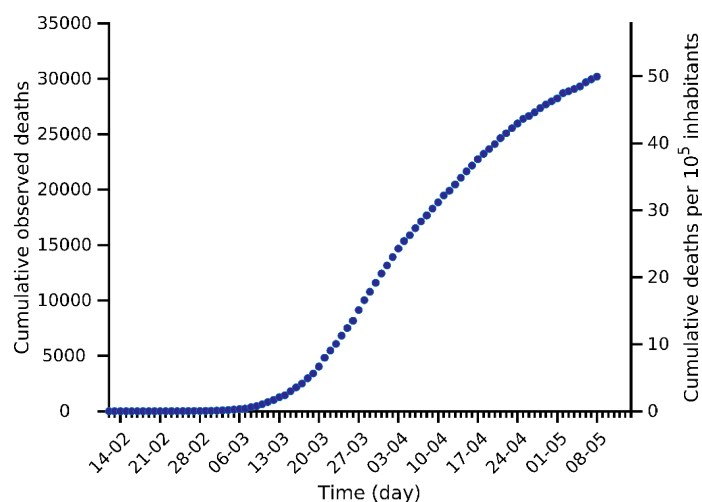
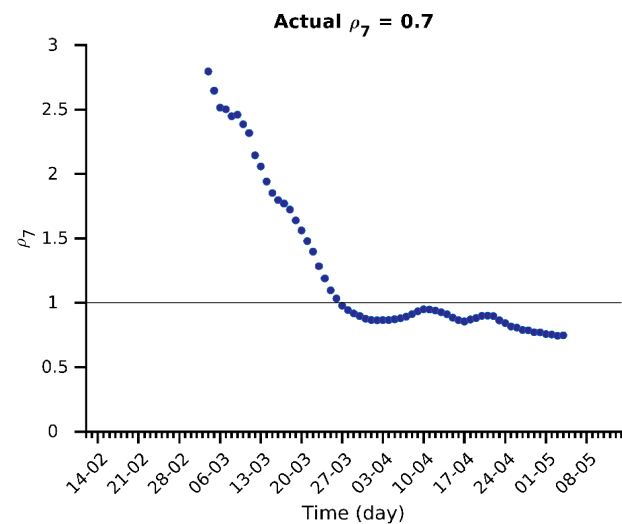
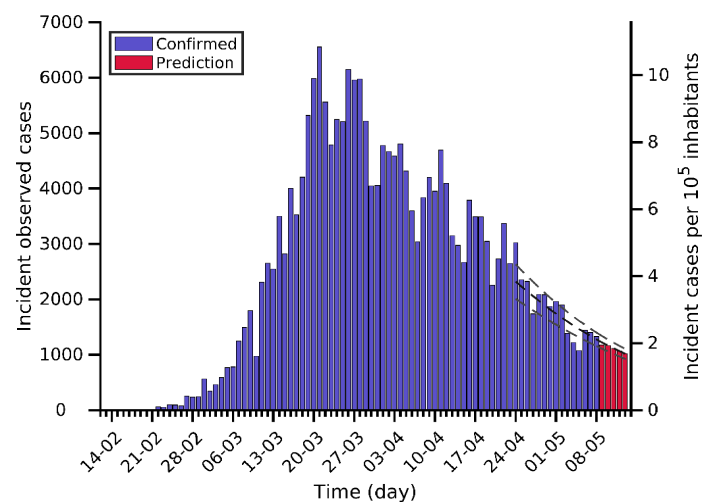
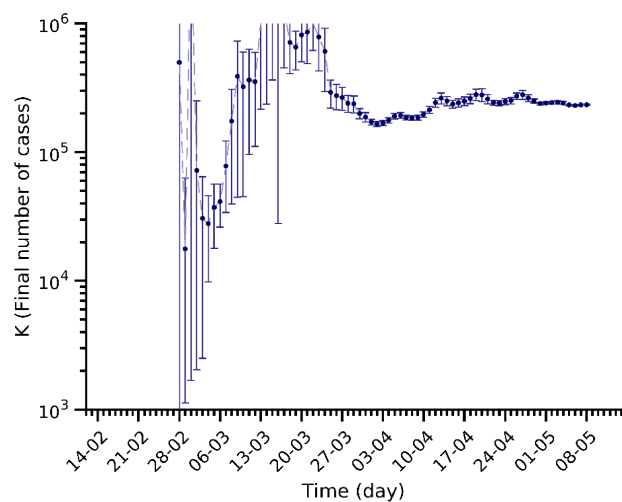
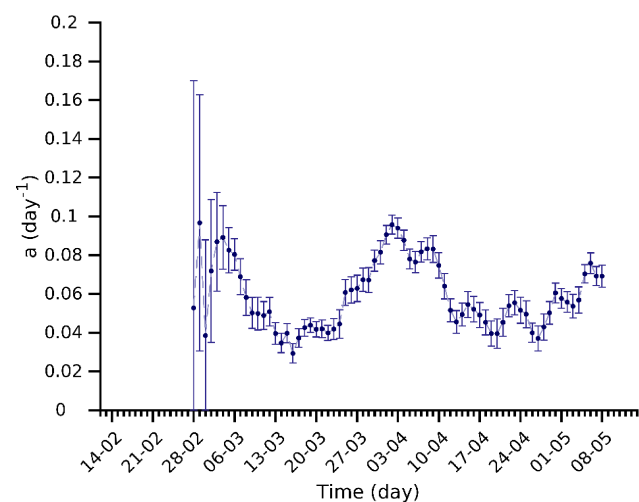
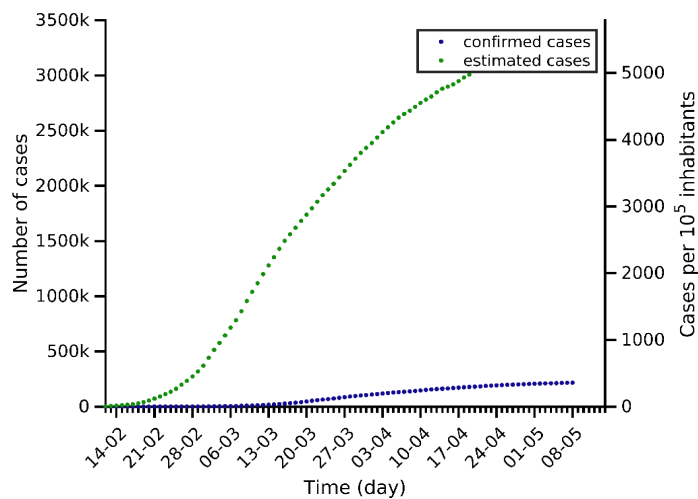
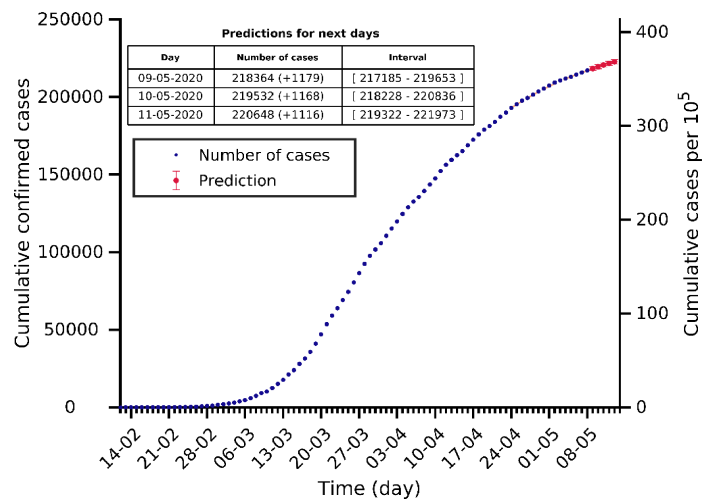
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>



# Spain 08-05-2020. Population: 47.0M. Current cumulated incidence: 474/10<sup>5</sup>

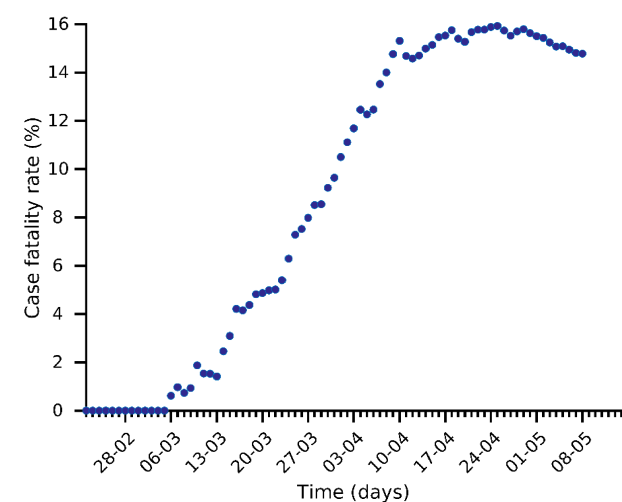
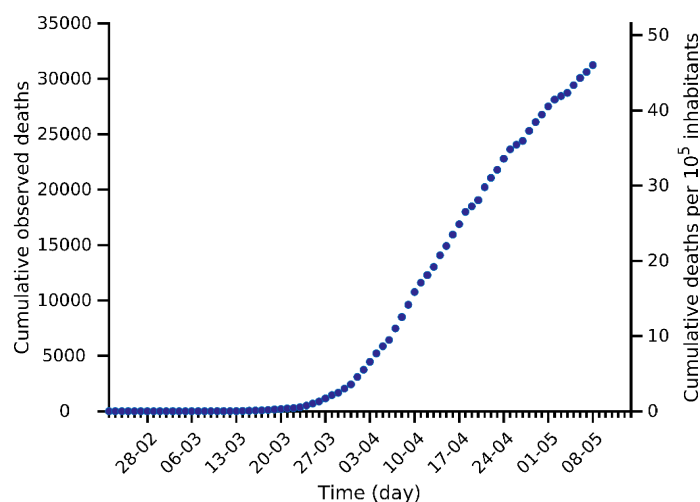
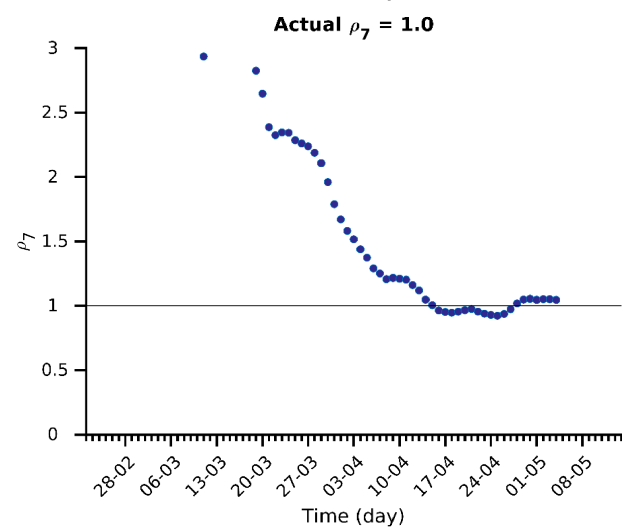
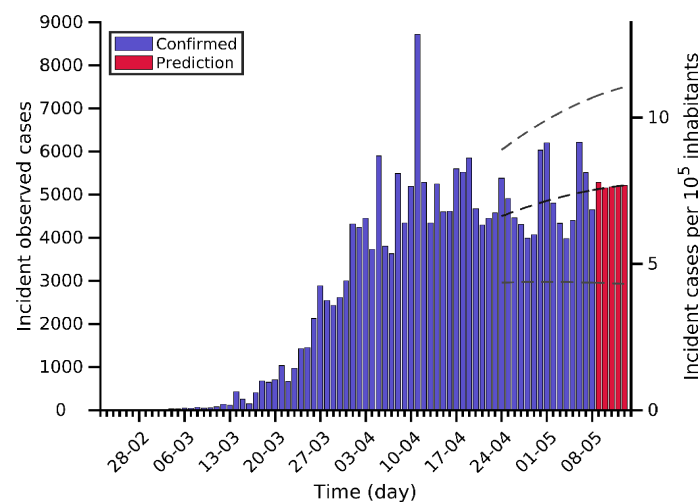
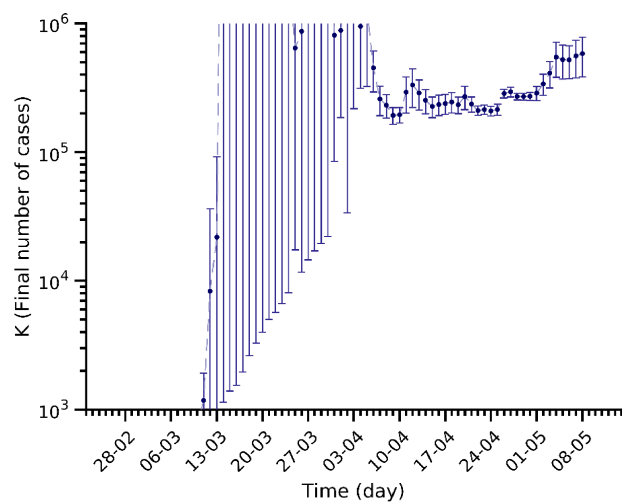
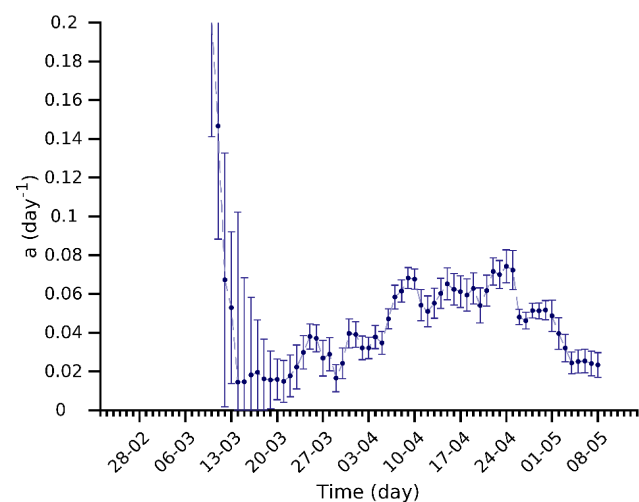
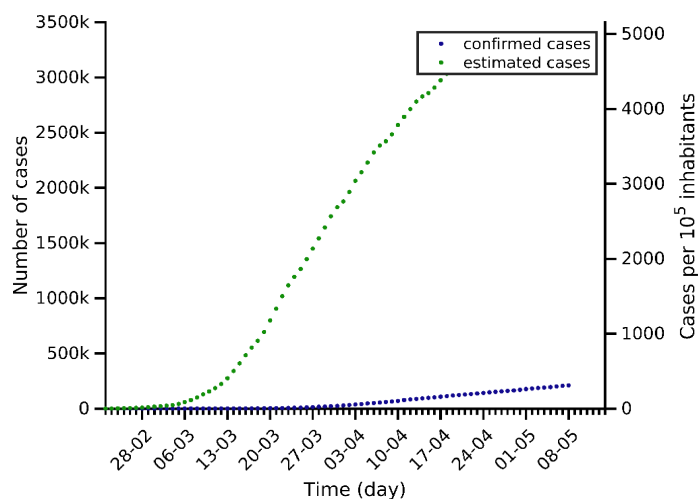
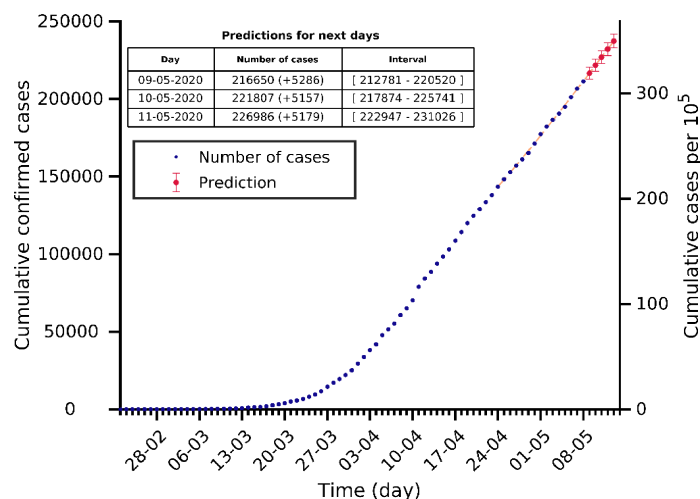


# Italy 08-05-2020. Population: 60.5M. Current cumulated incidence: 359/10<sup>5</sup>

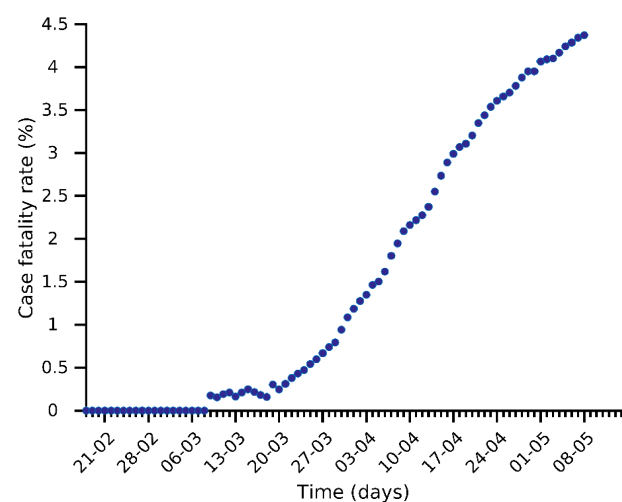
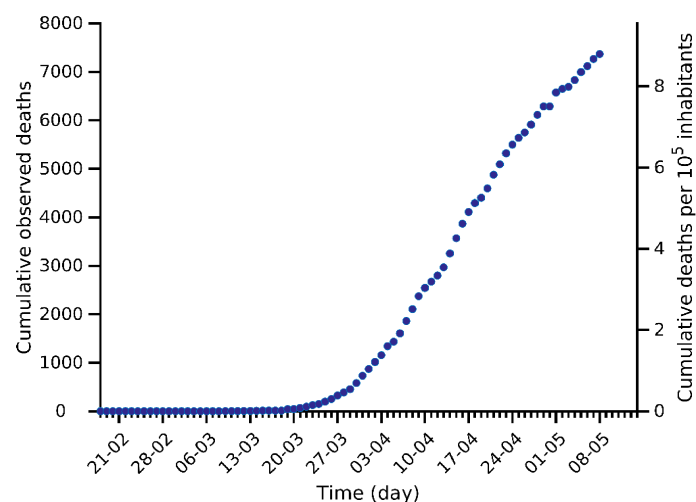
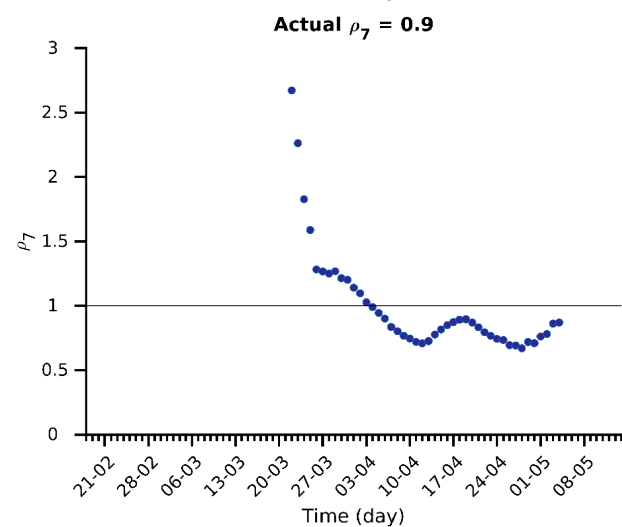
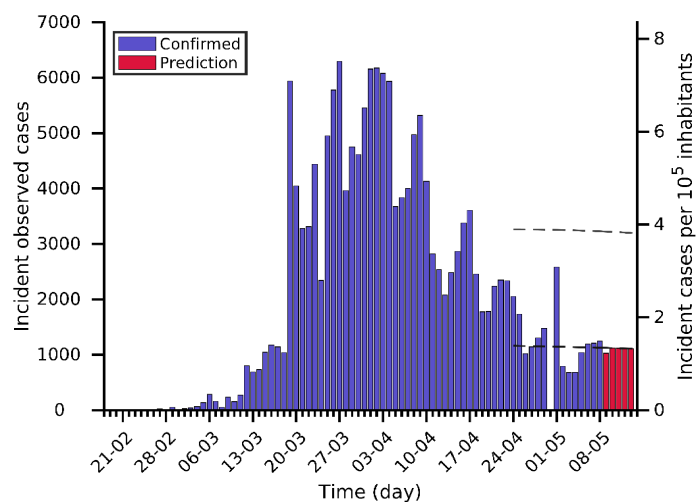
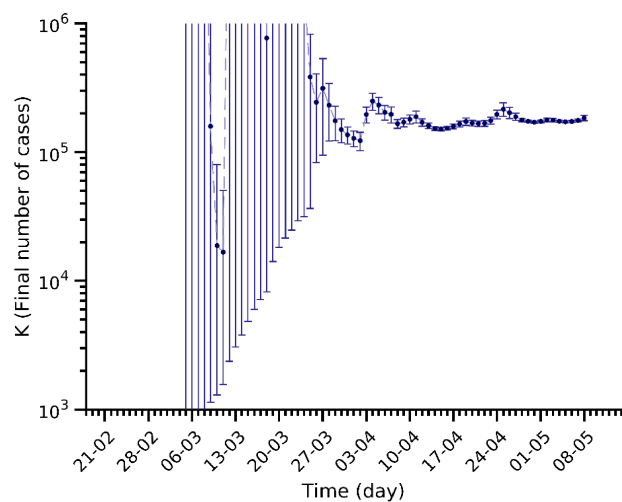
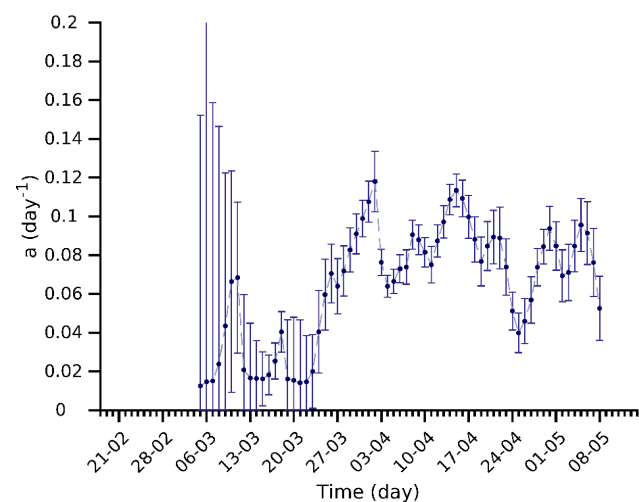
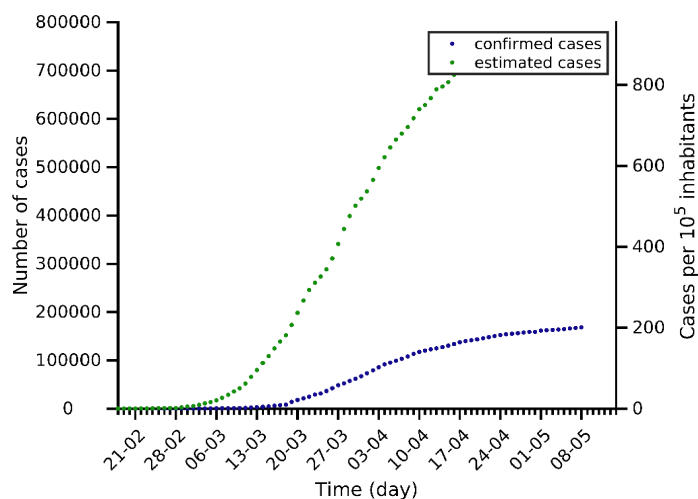
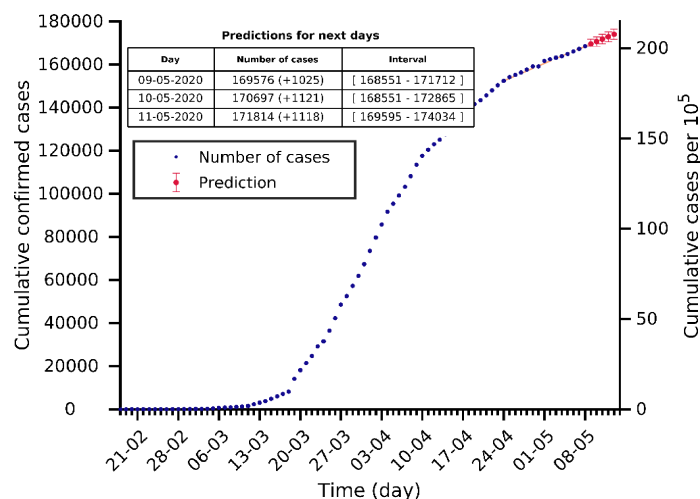




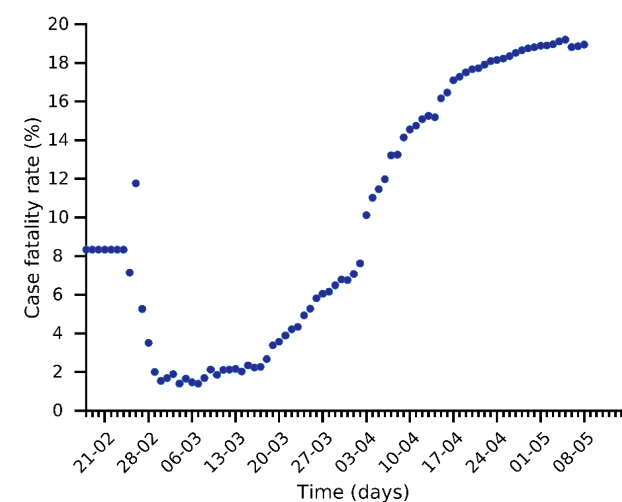
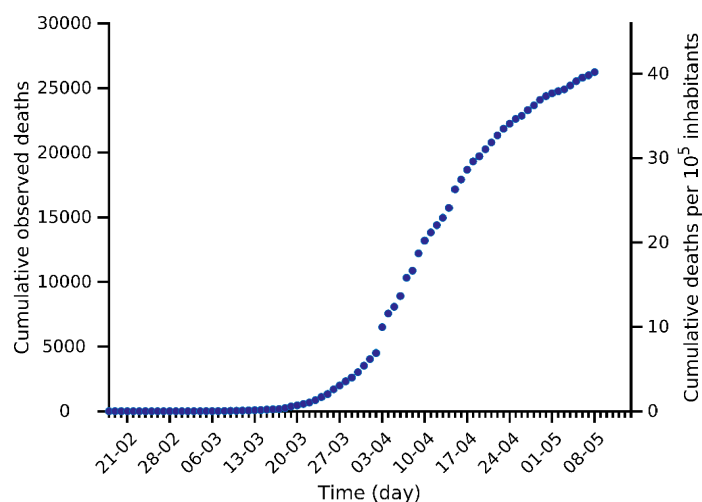
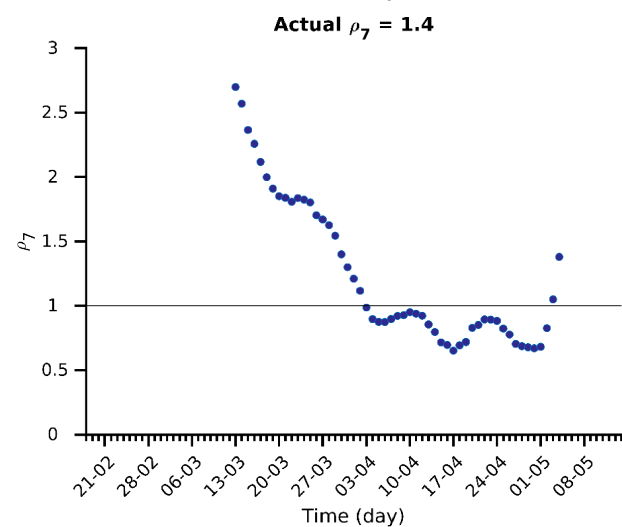
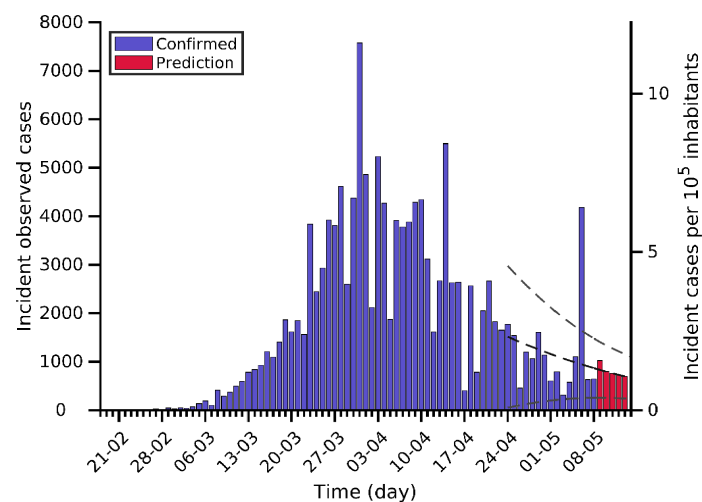
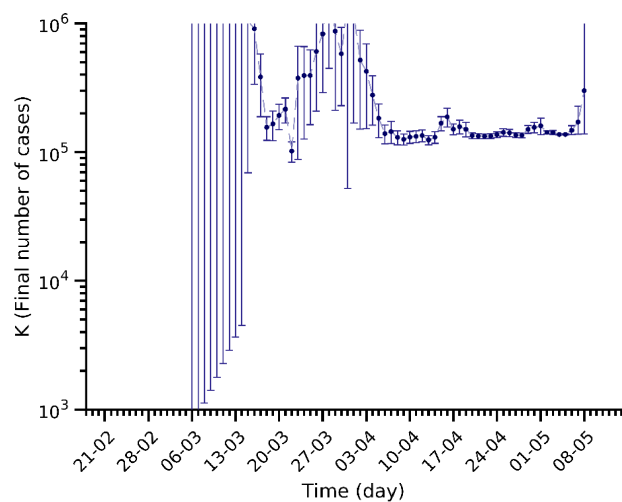
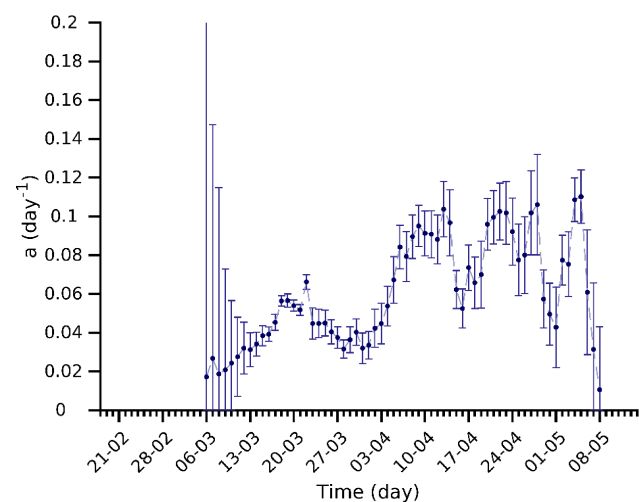
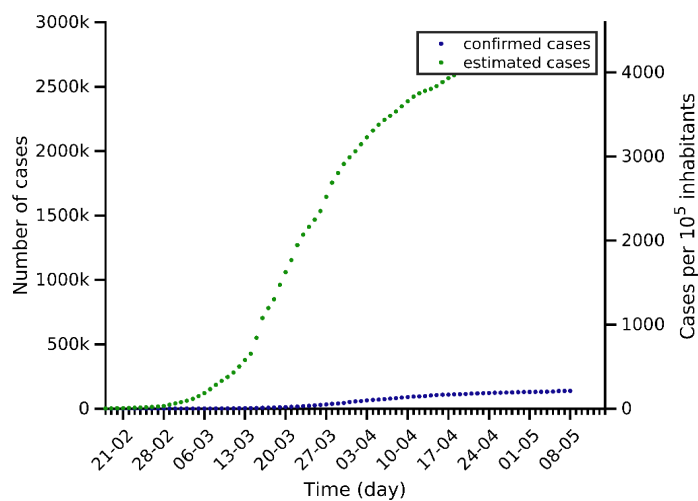
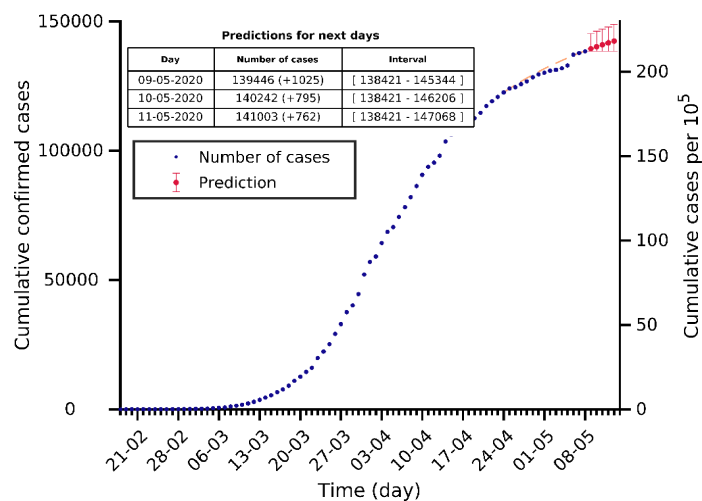
# UK 08-05-2020. Population: 67.9M. Current cumulated incidence: 311/10<sup>5</sup>



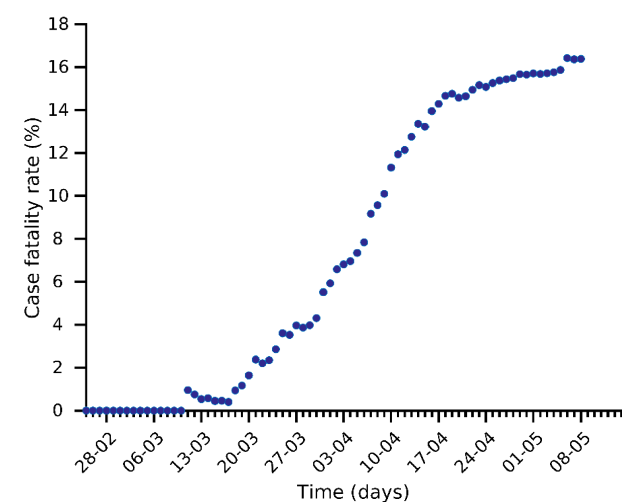
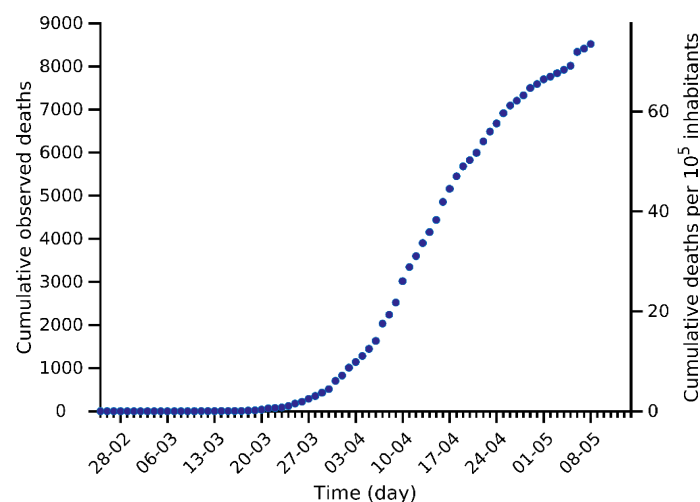
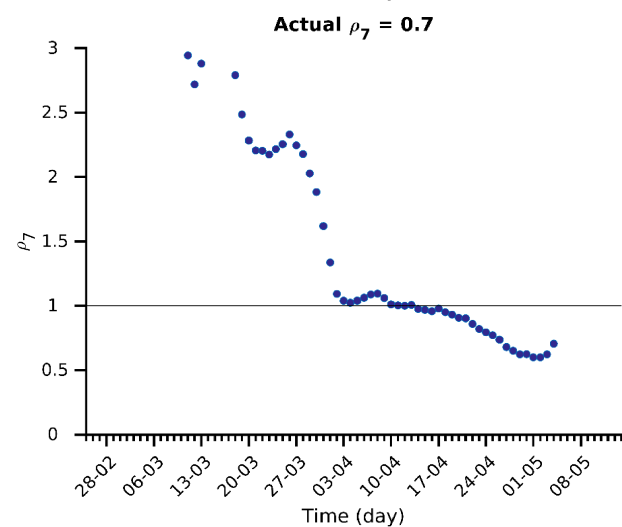
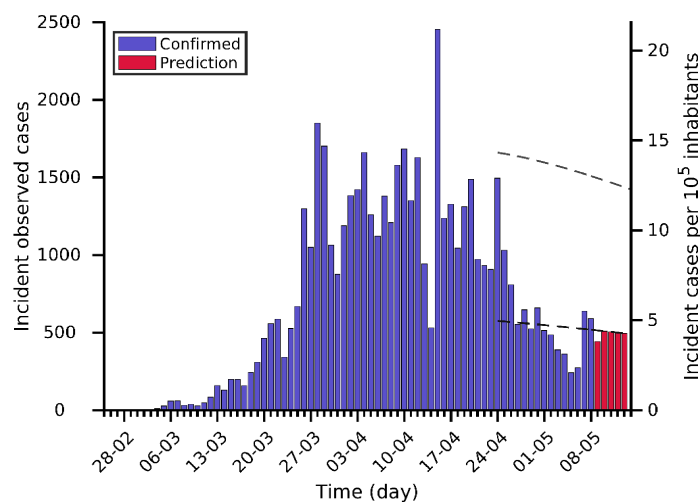
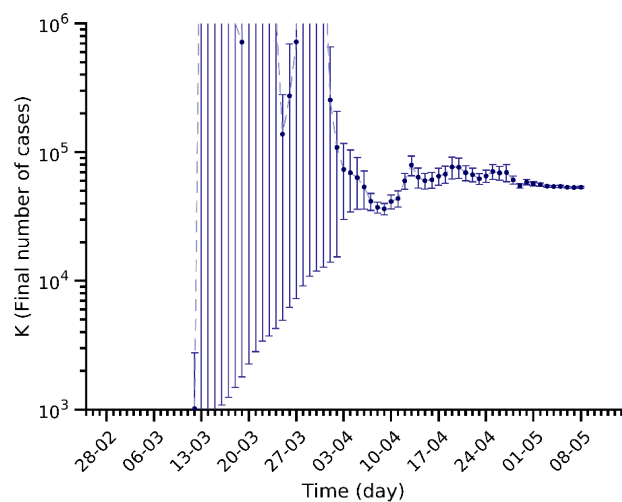
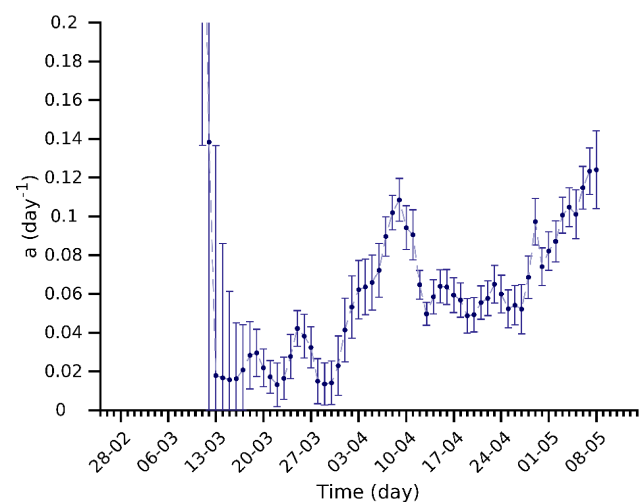
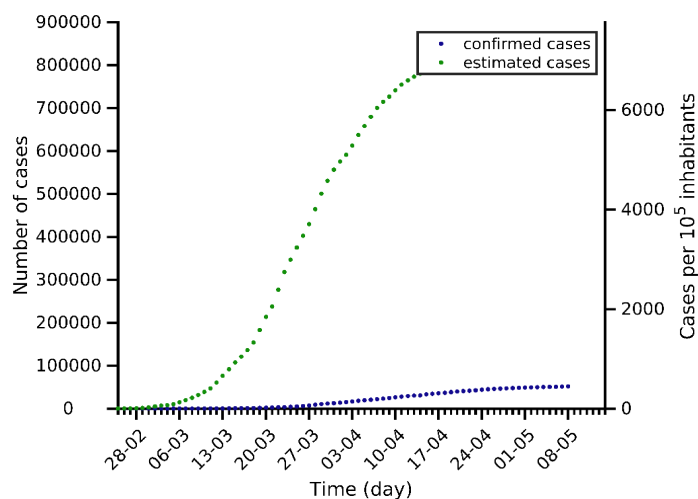
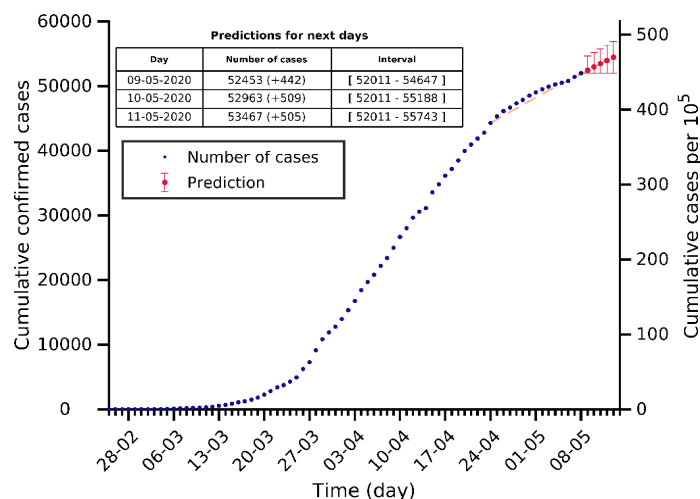
# Germany 08-05-2020. Population: 83.8M. Current cumulated incidence: 201/10<sup>5</sup>



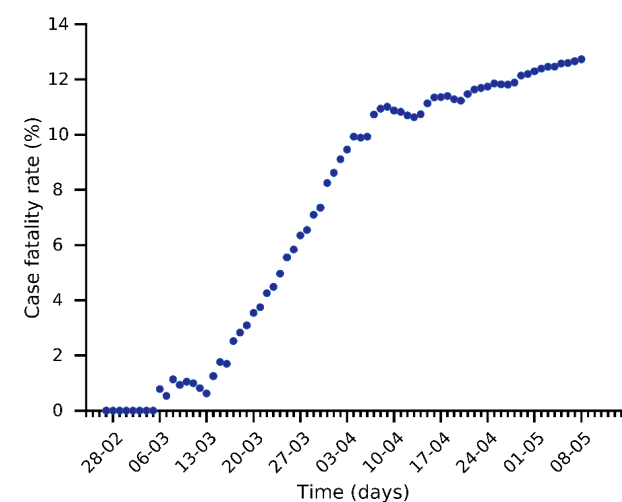
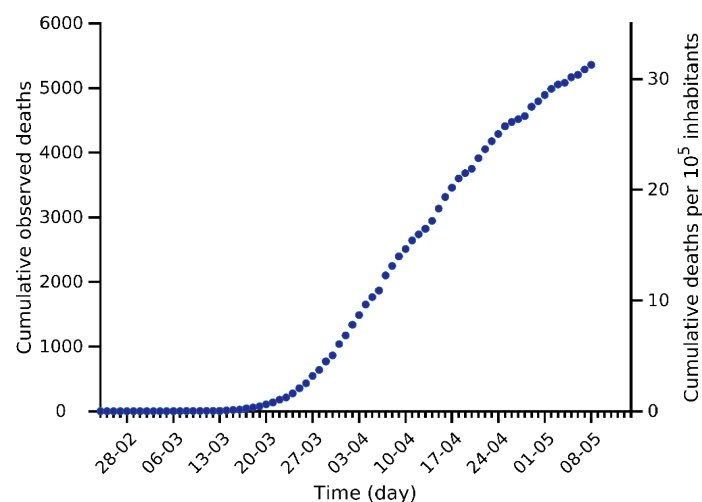
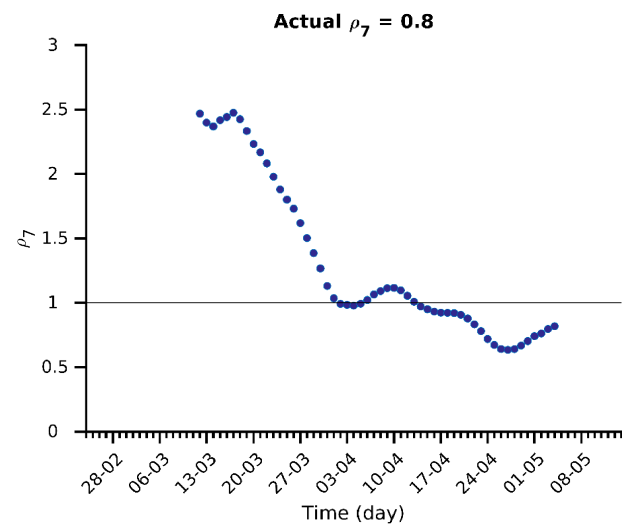
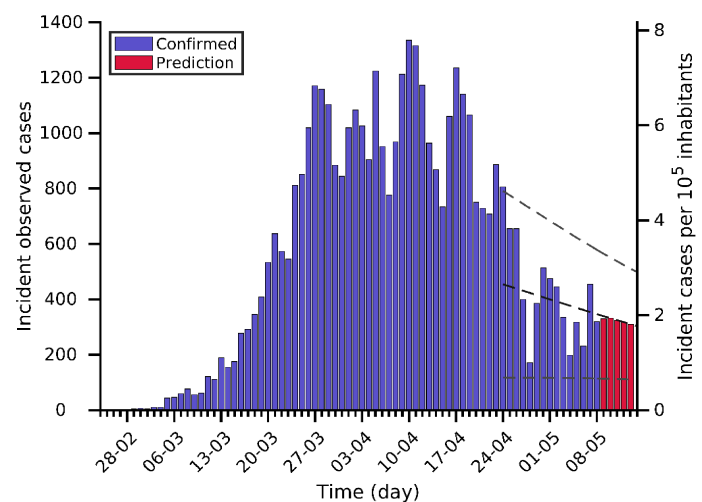
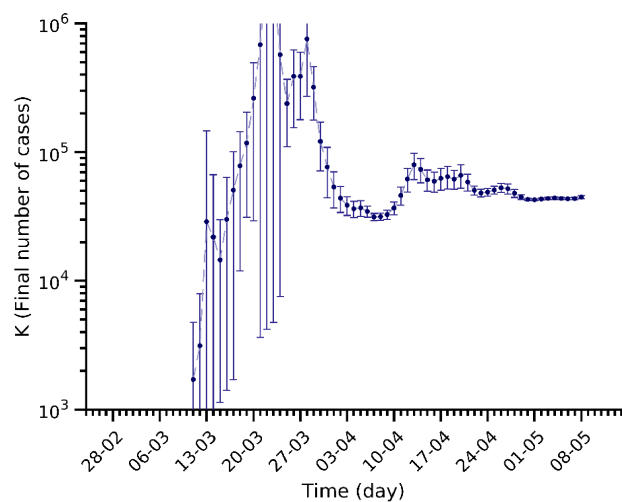
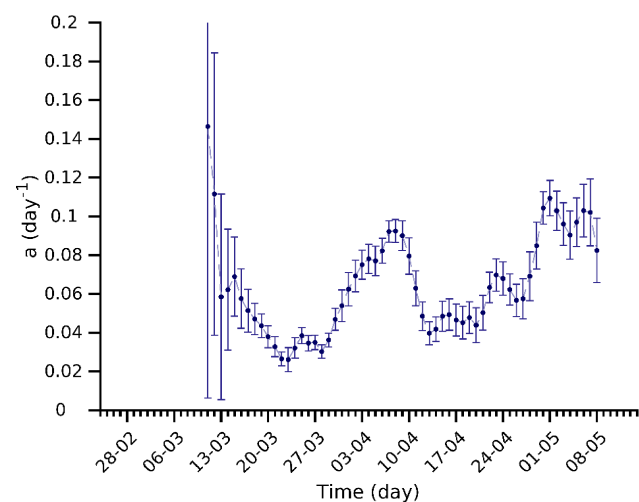
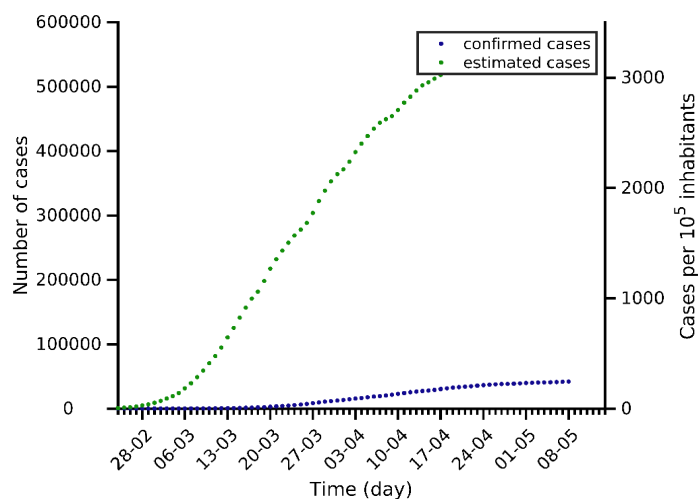
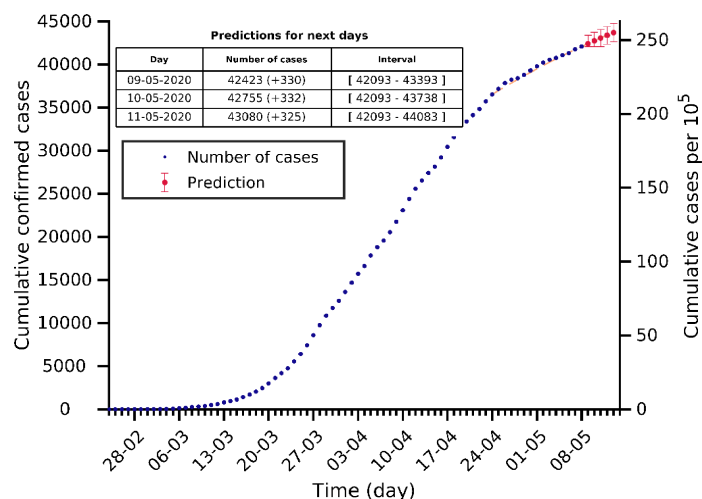
# France 08-05-2020. Population: 65.3M. Current cumulated incidence: 212/10<sup>5</sup>



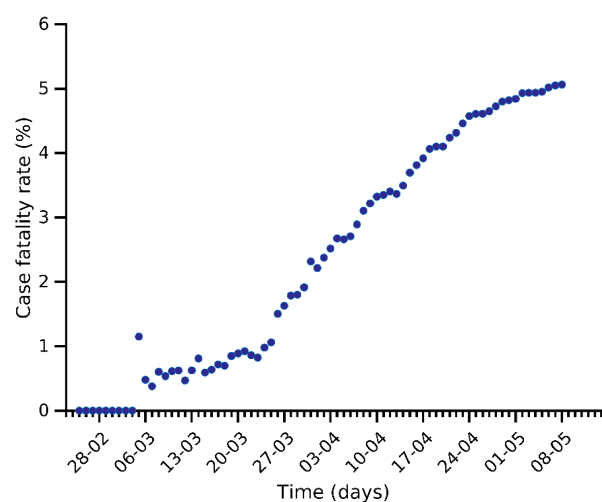
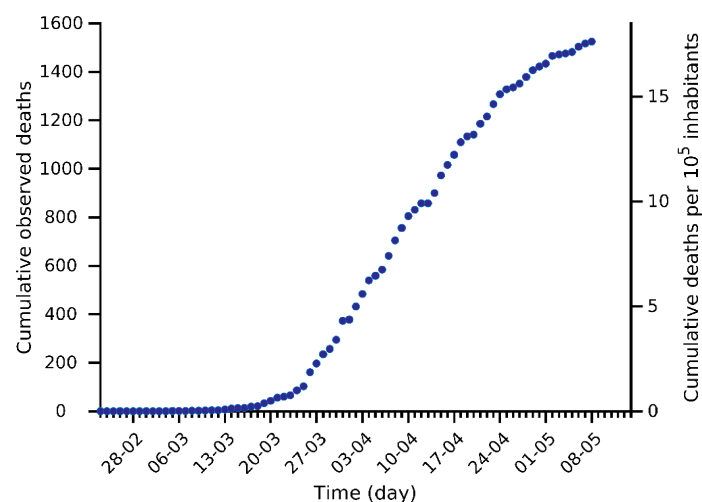
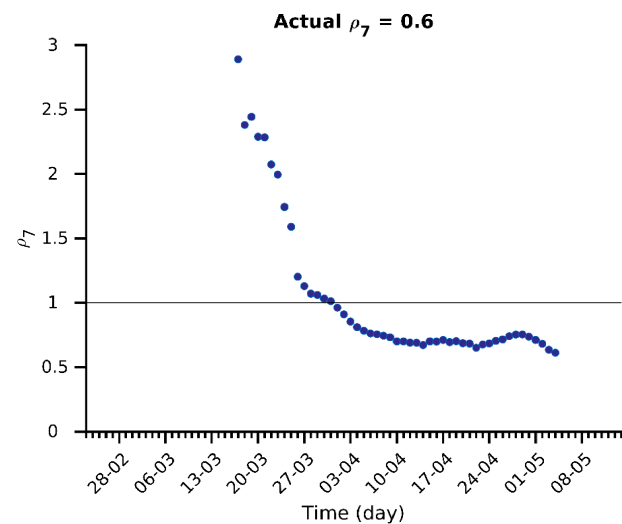
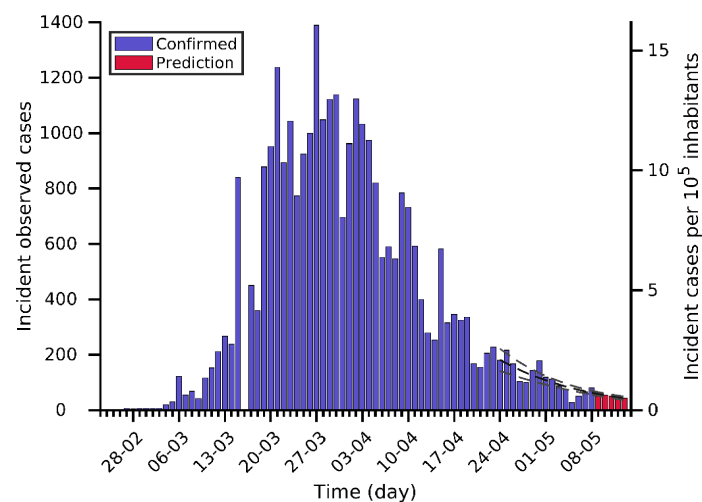
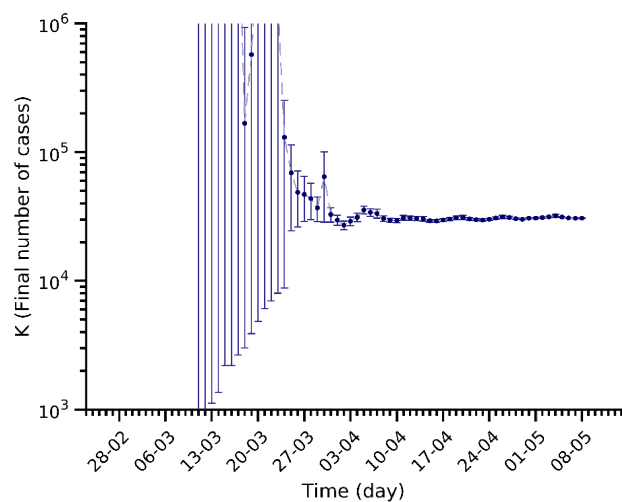
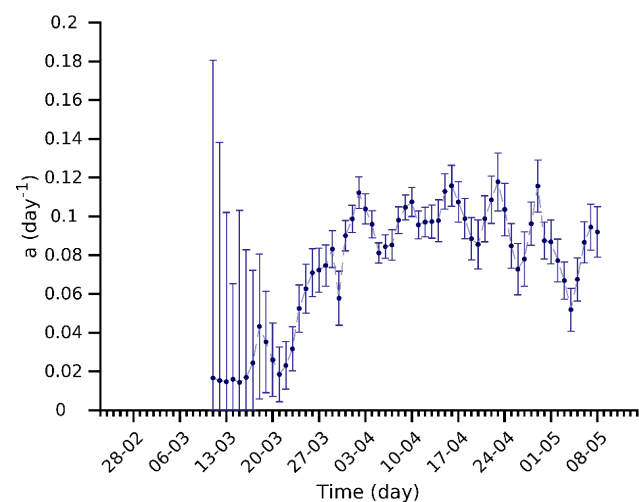
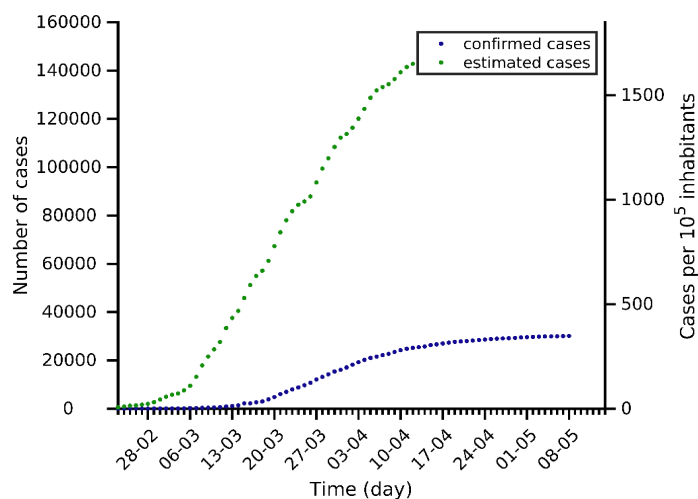
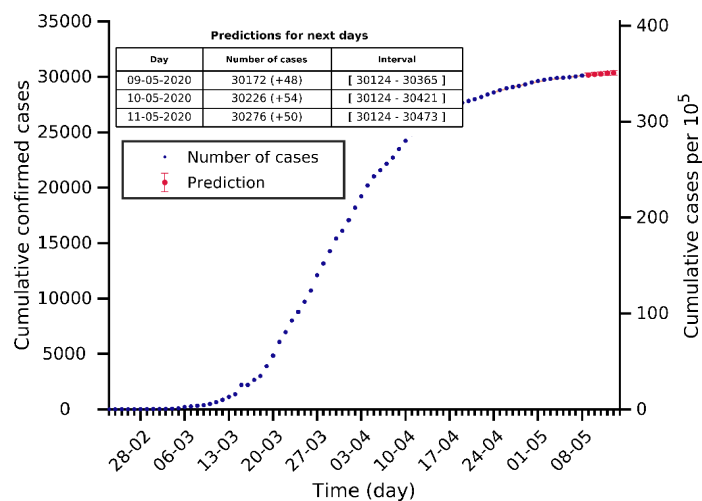
# Belgium 08-05-2020. Population: 11.6M. Current cumulated incidence: 449/10<sup>5</sup>



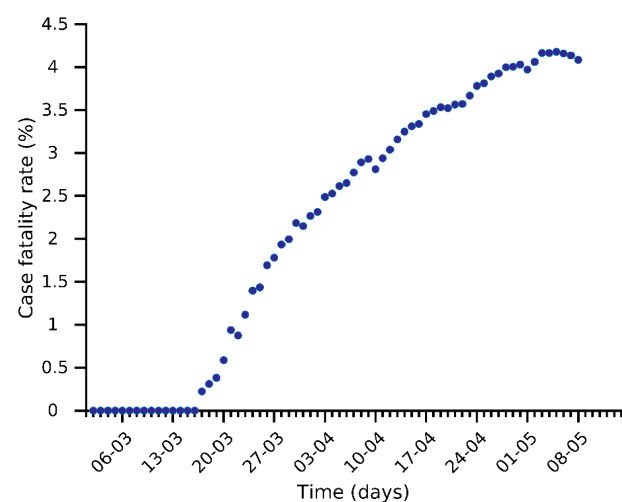
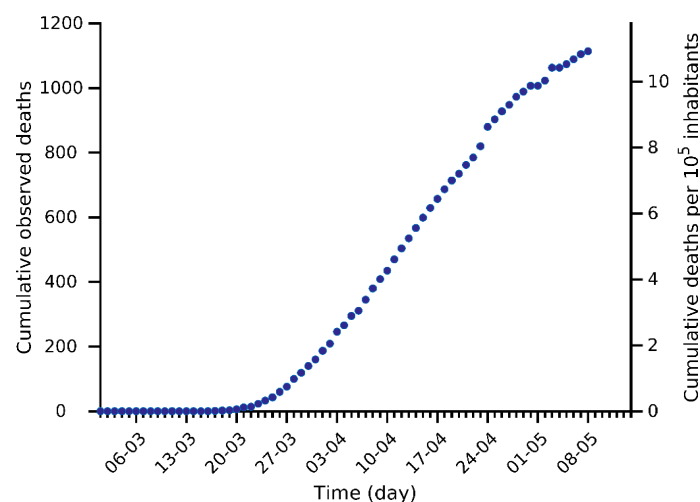
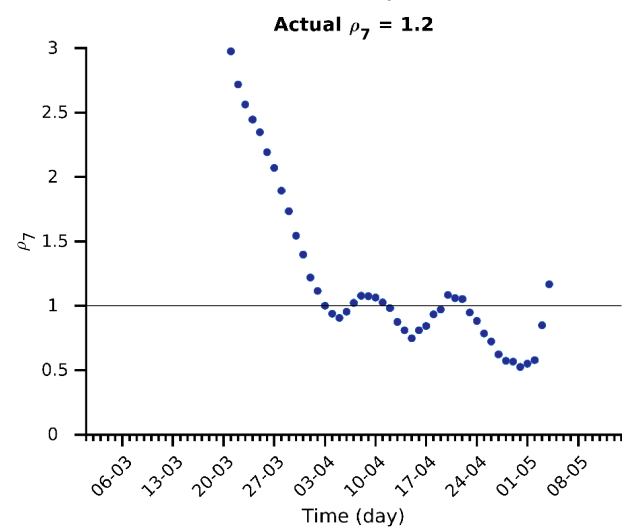
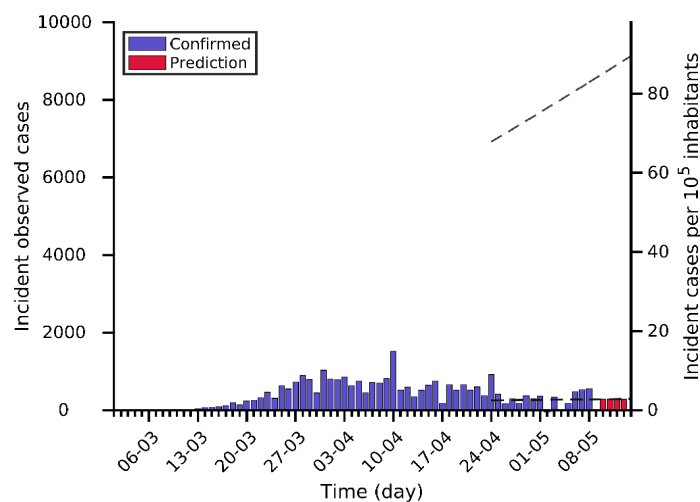
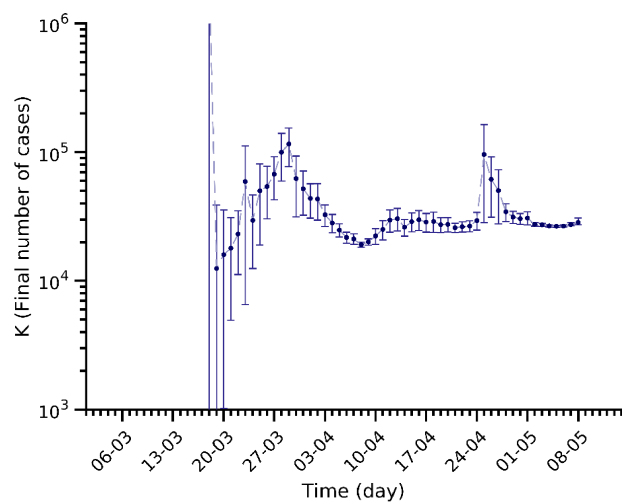
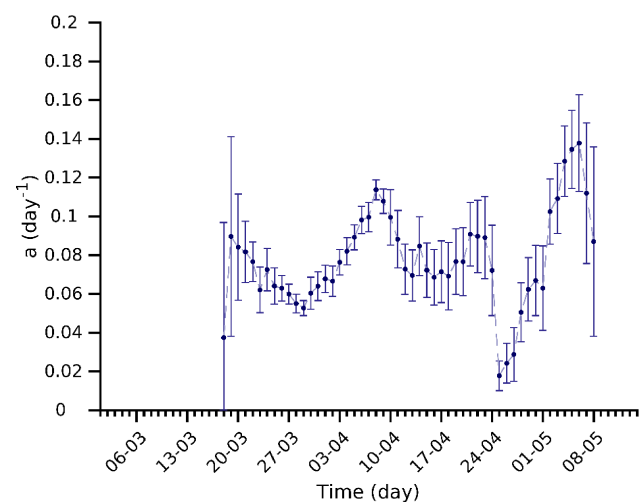
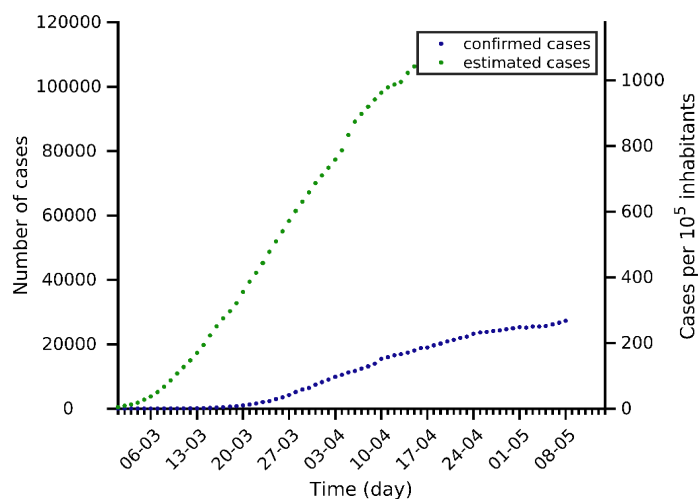
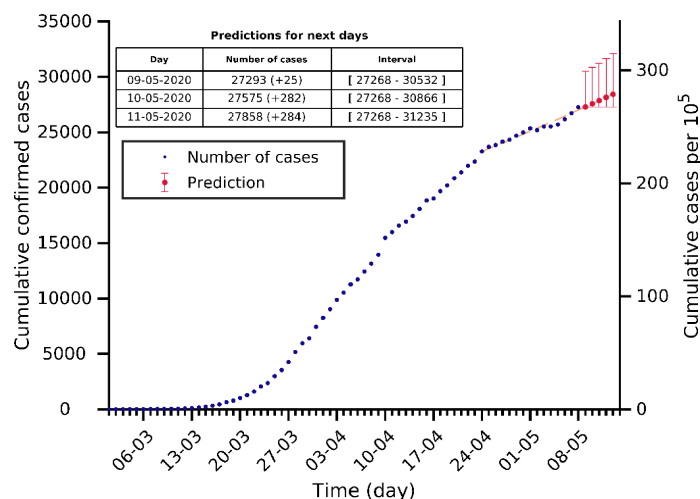
# Netherlands 08-05-2020. Population: 17.1M. Current cumulated incidence: 246/10<sup>5</sup>



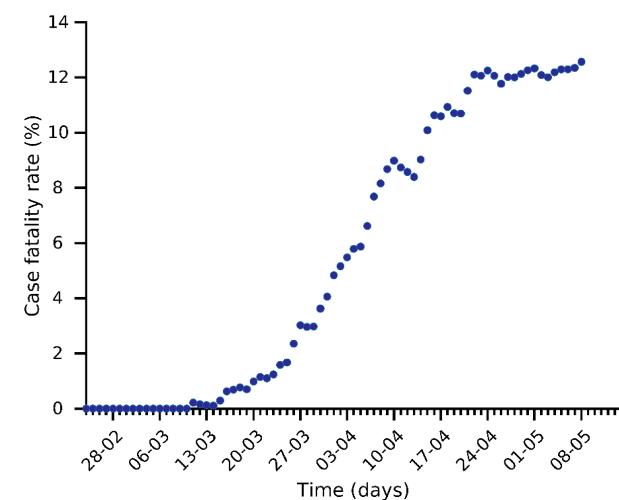
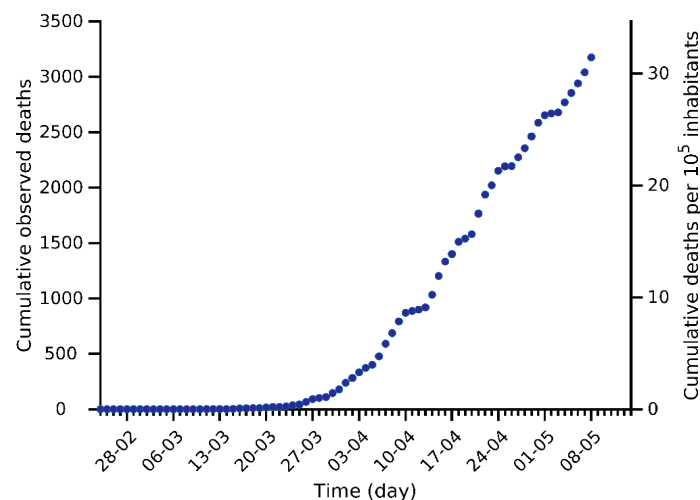
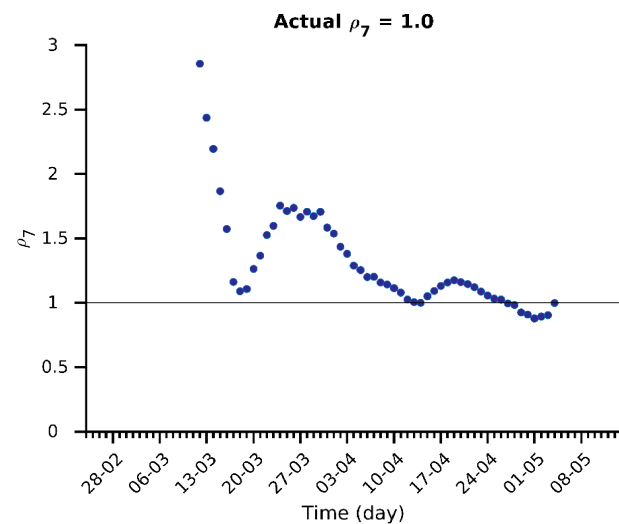
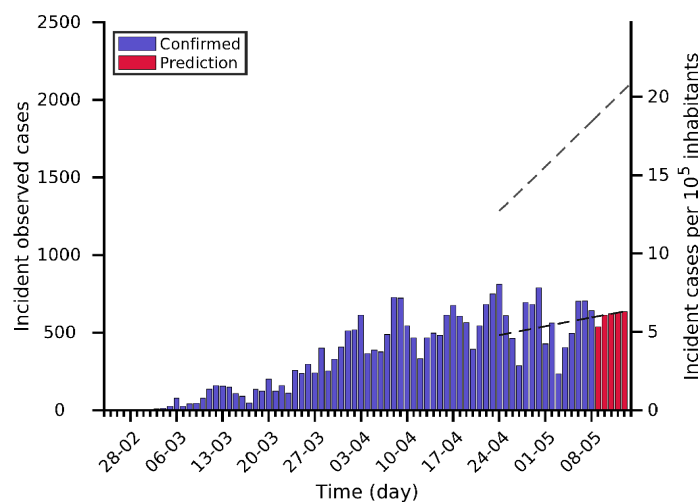
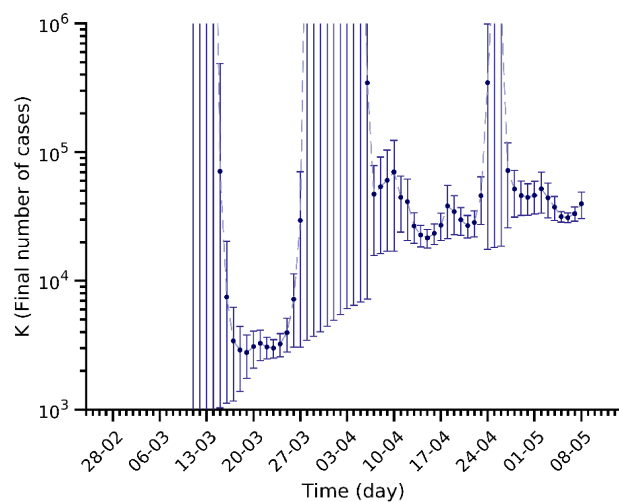
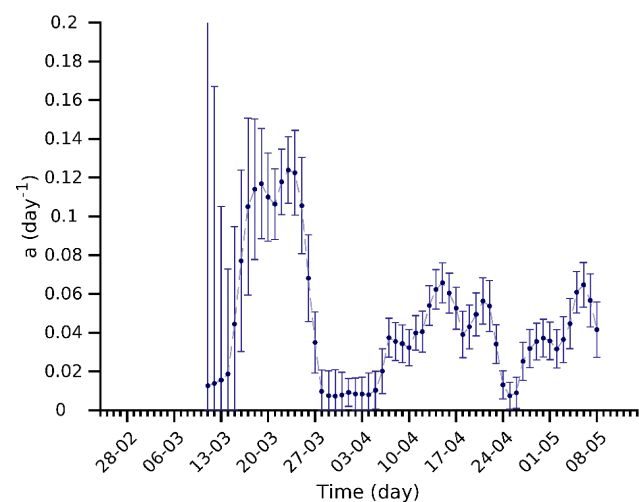
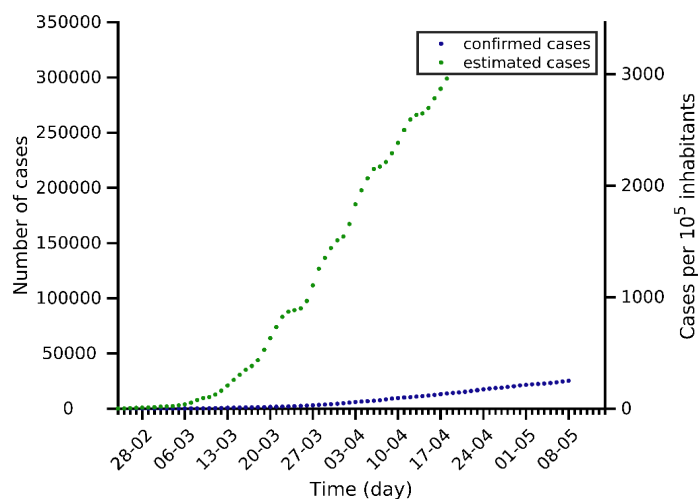
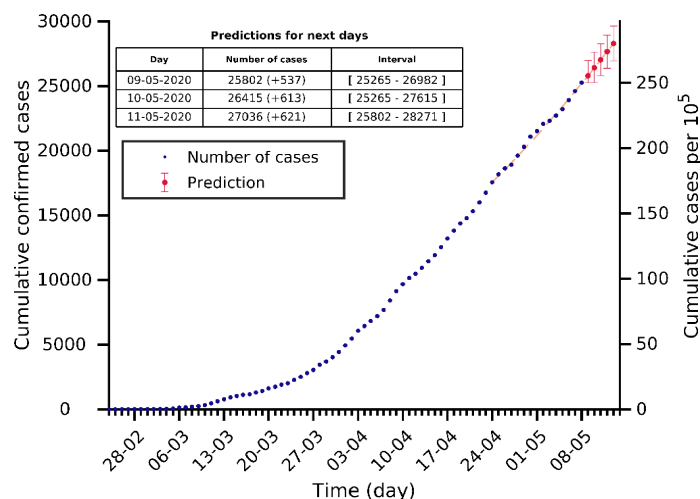
# Switzerland 08-05-2020. Population: 8.7M. Current cumulated incidence: 348/10<sup>5</sup>



# Portugal 08-05-2020. Population: 10.2M. Current cumulated incidence: 267/10<sup>5</sup>

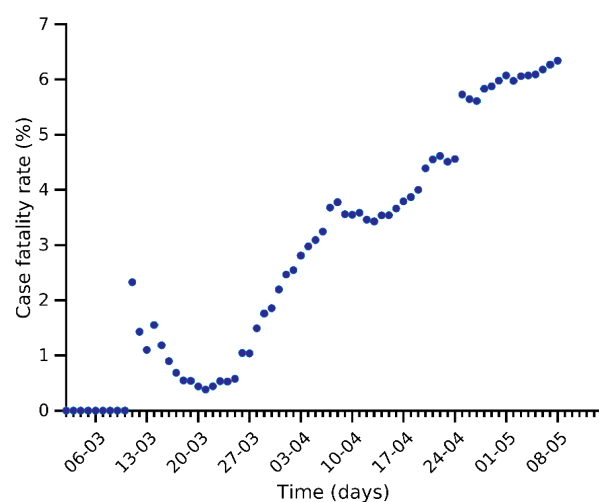
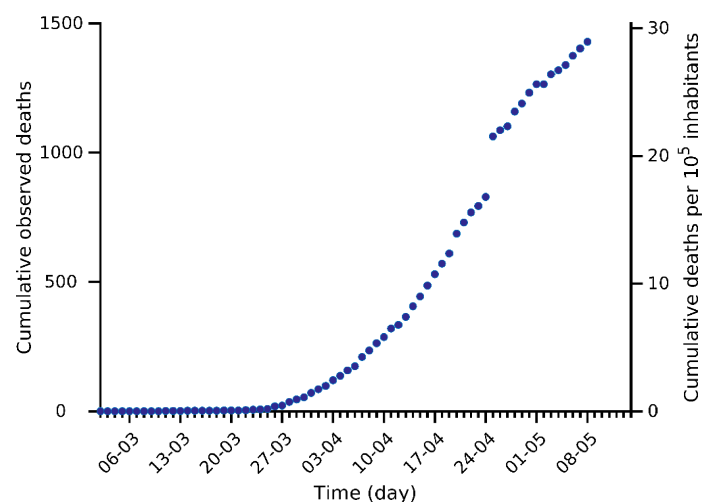
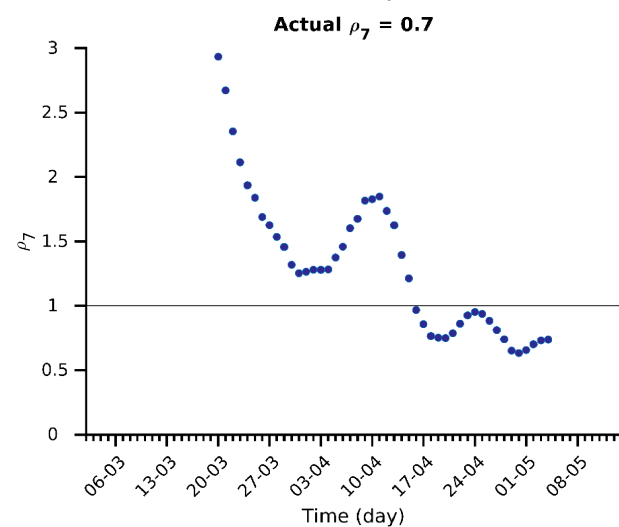
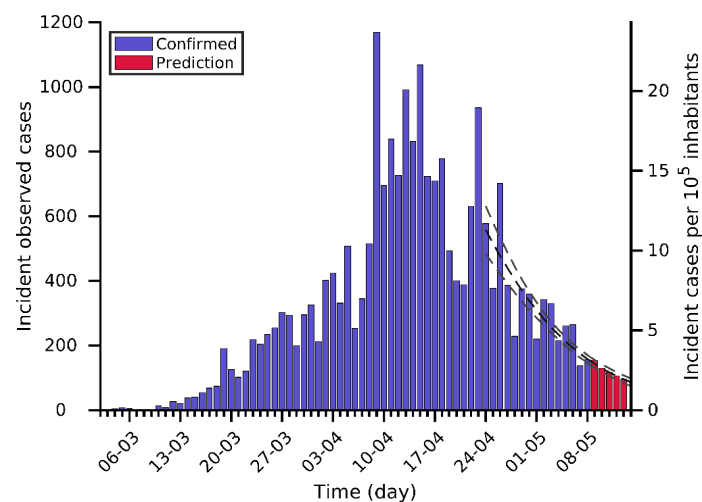
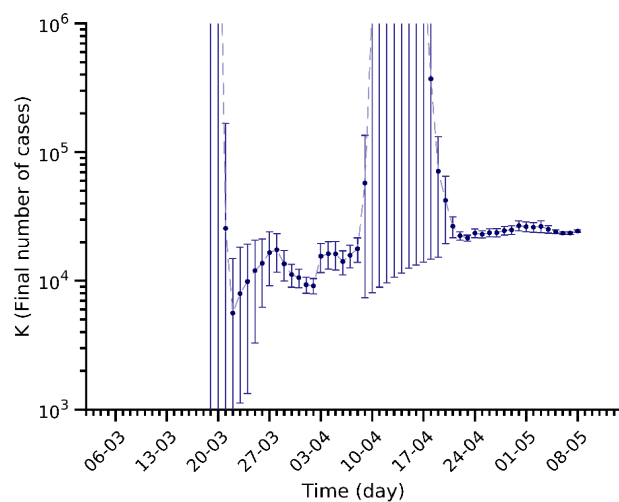
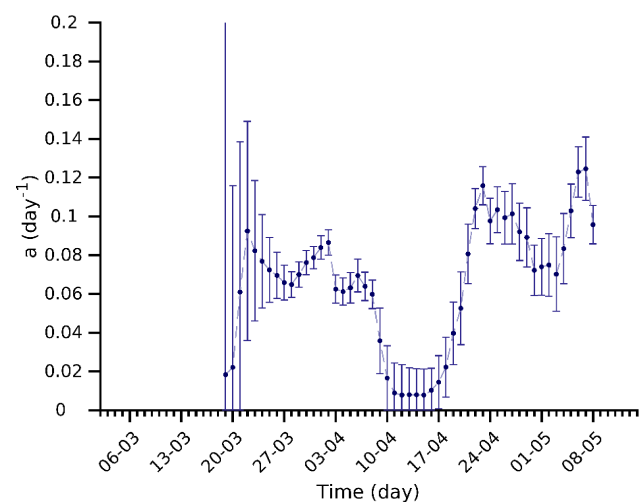
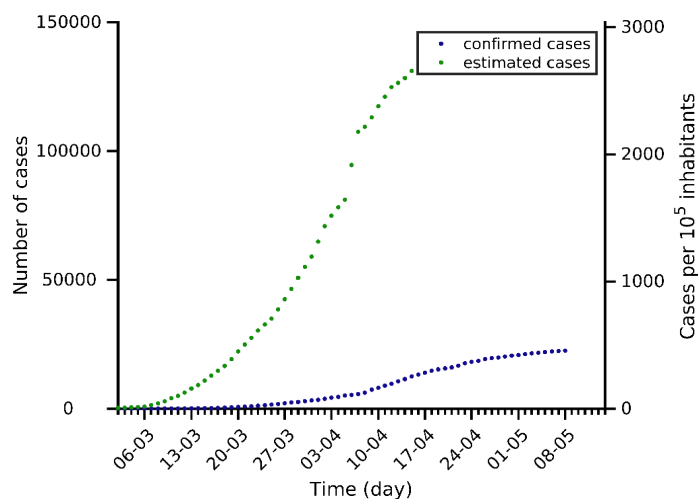
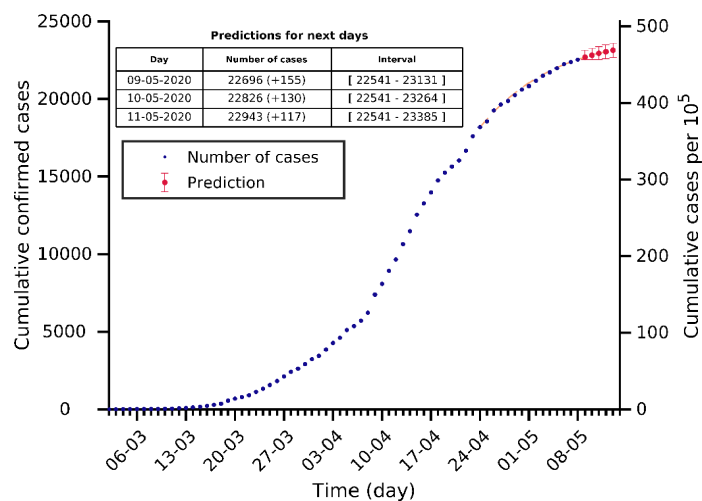


# Sweden 08-05-2020. Population: 10.1M. Current cumulated incidence: 250/10<sup>5</sup>

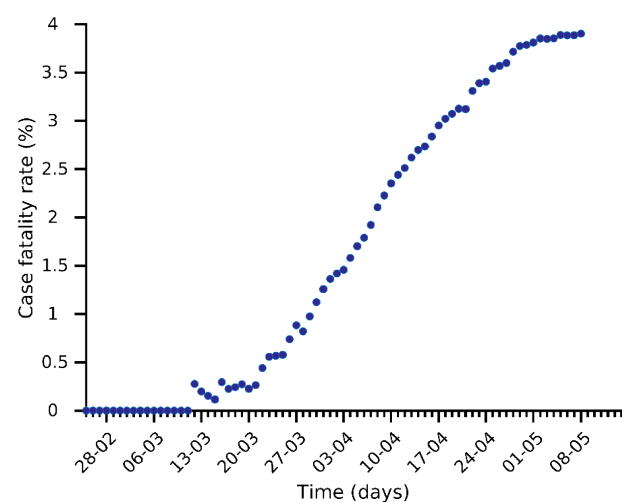
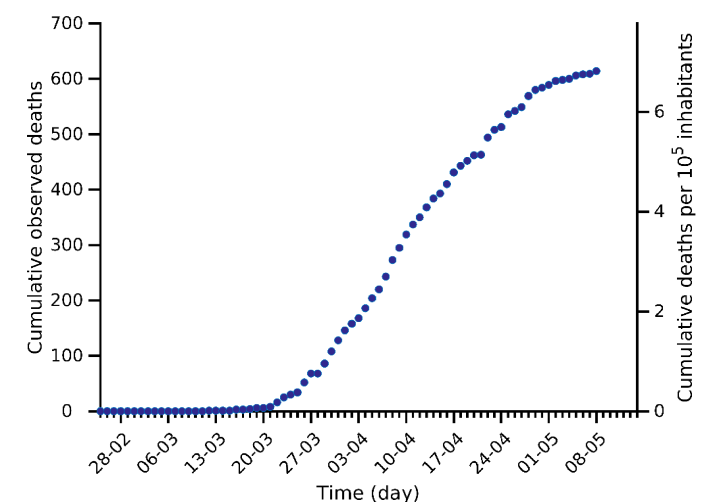
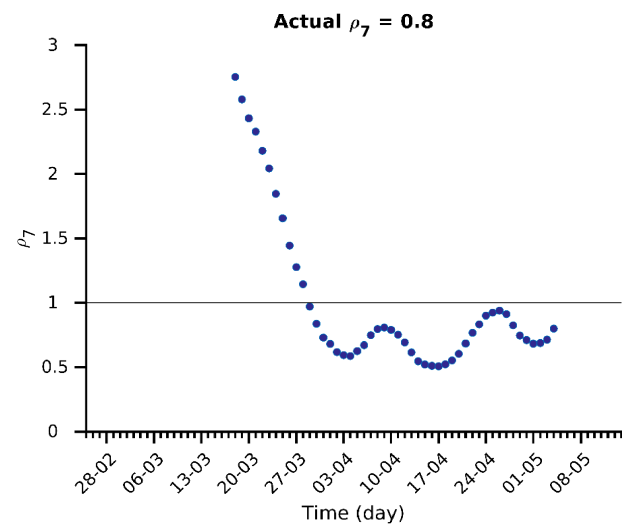
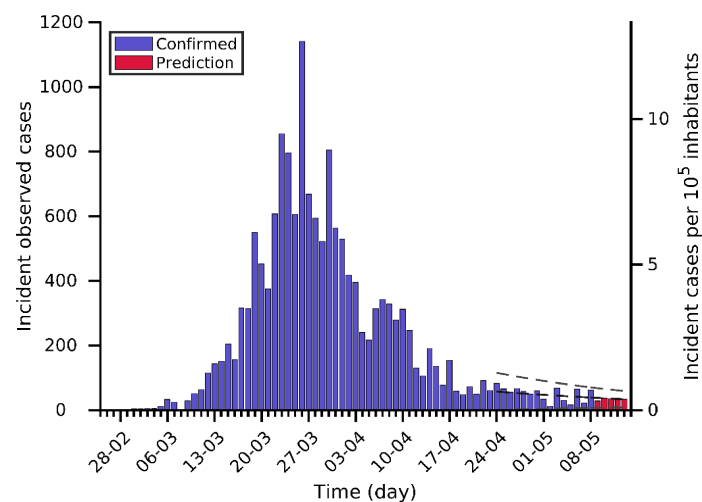
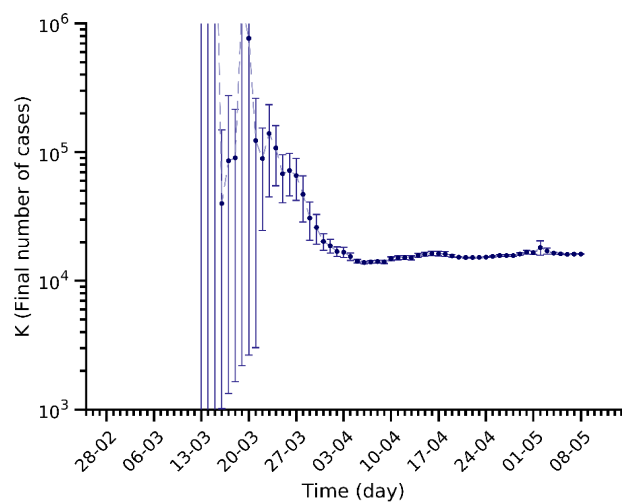
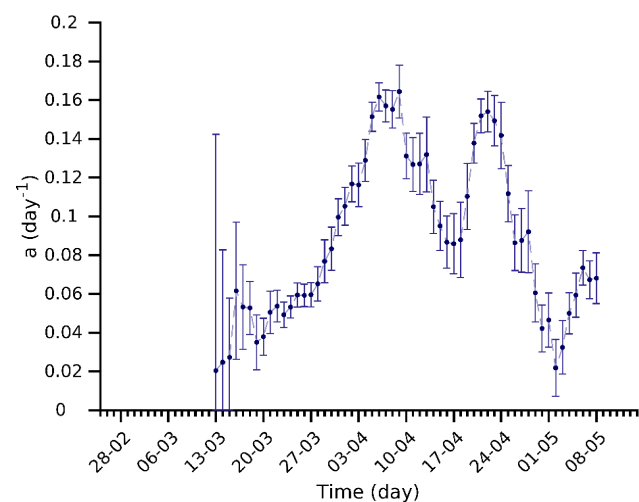
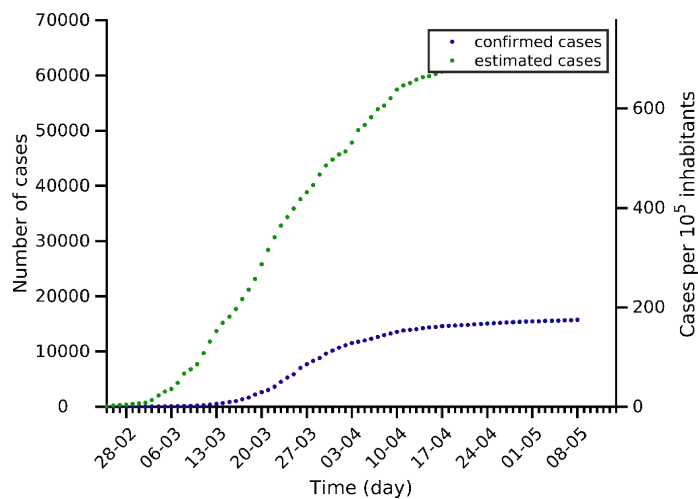
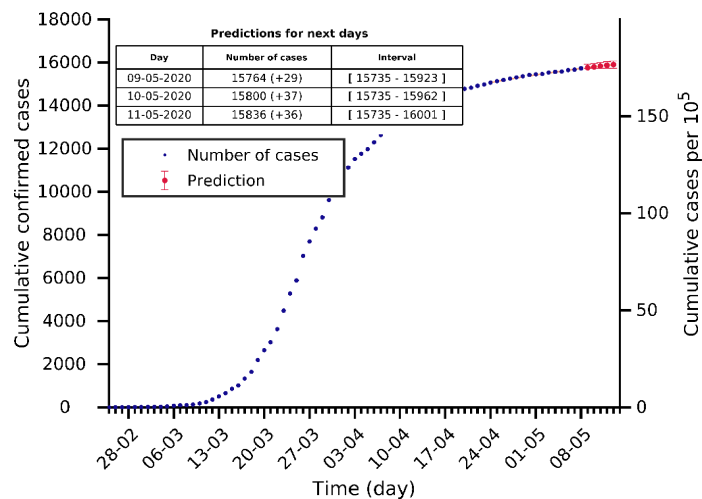




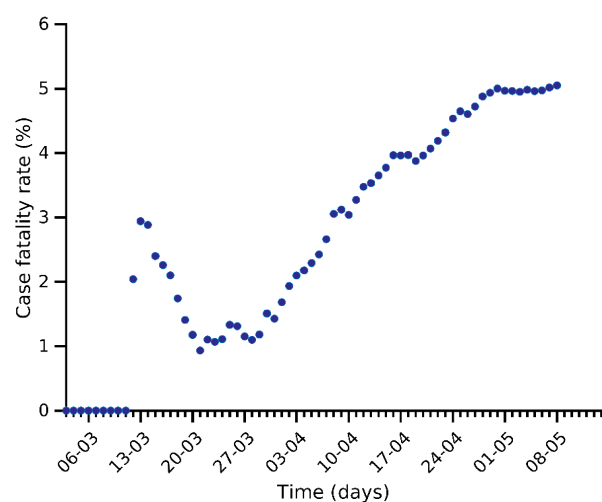
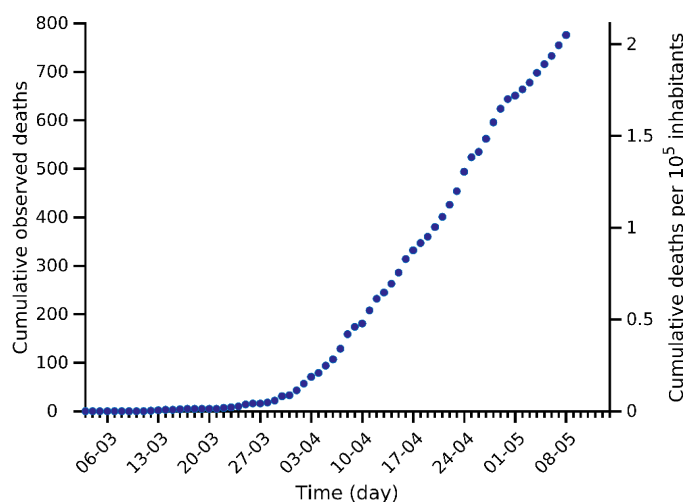
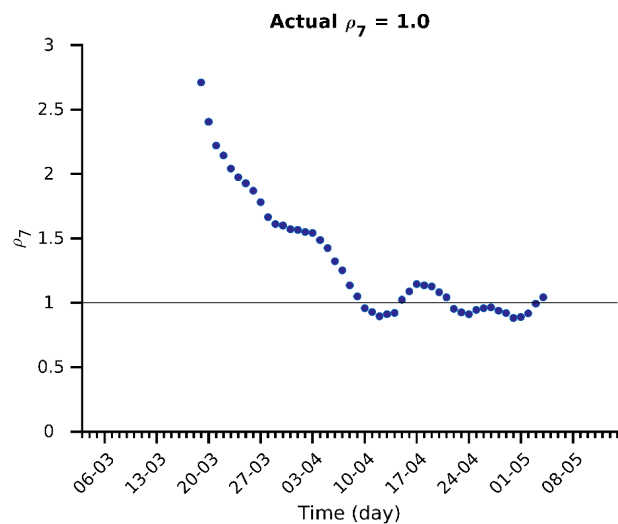
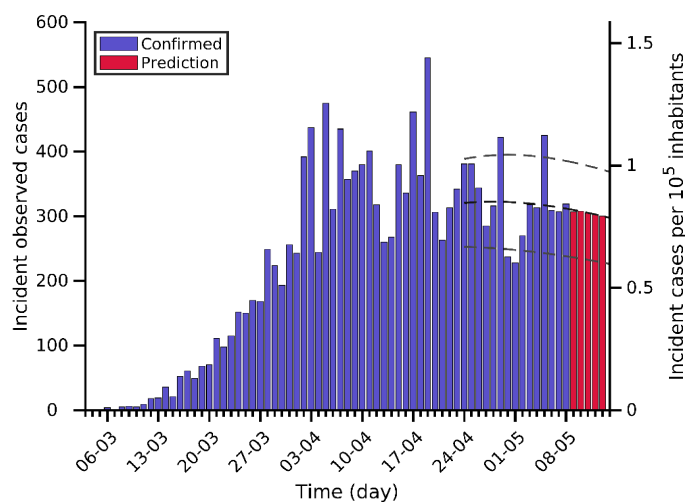
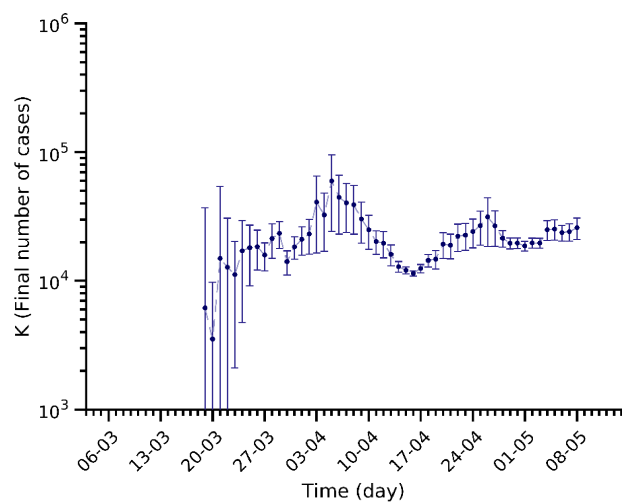
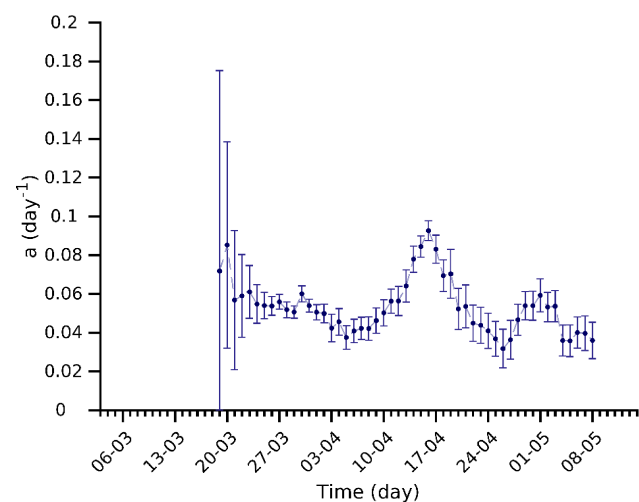
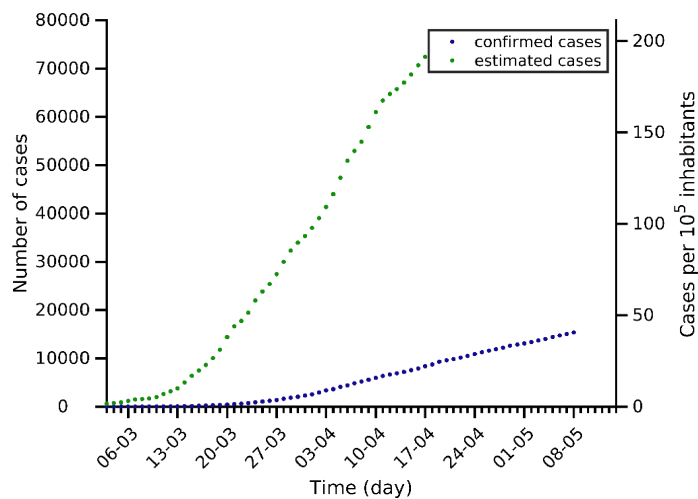
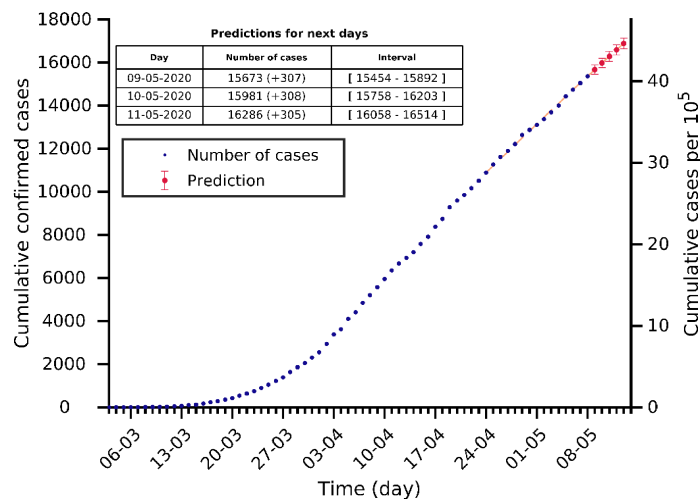
# Ireland 08-05-2020. Population: 4.9M. Current cumulated incidence: 456/10<sup>5</sup>



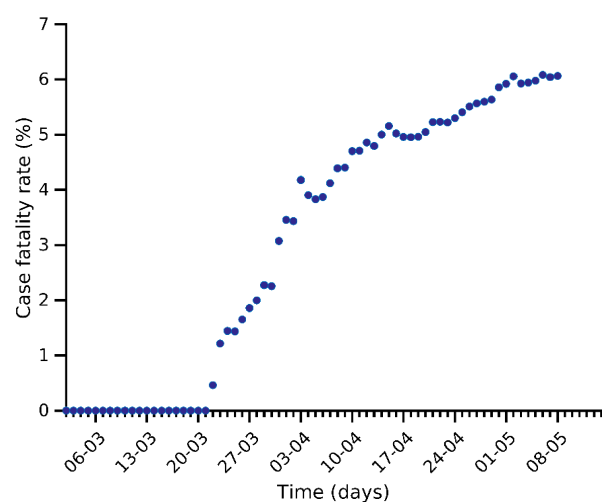
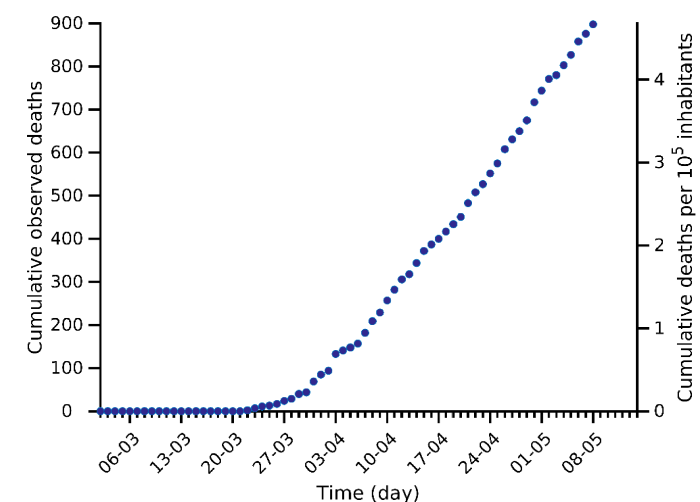
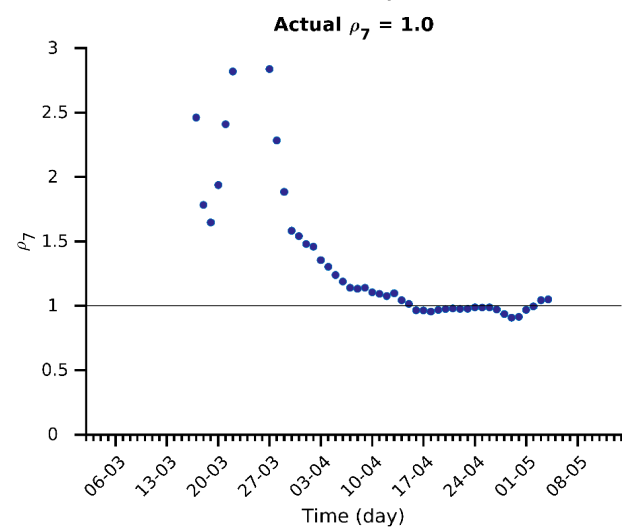
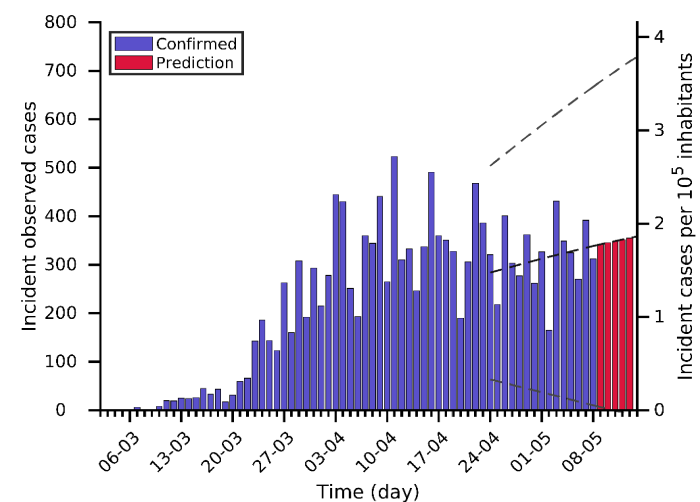
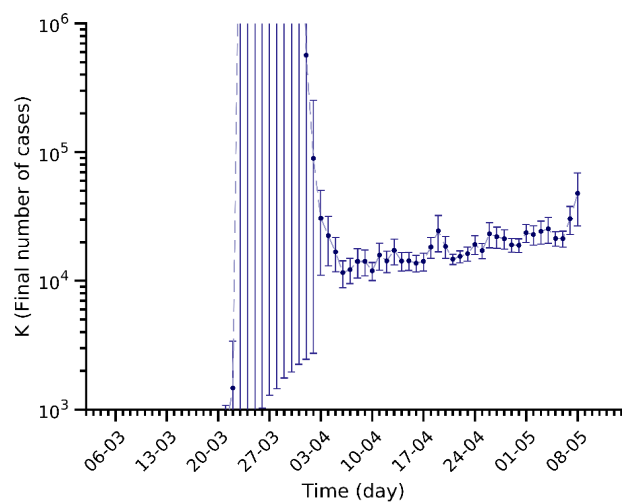
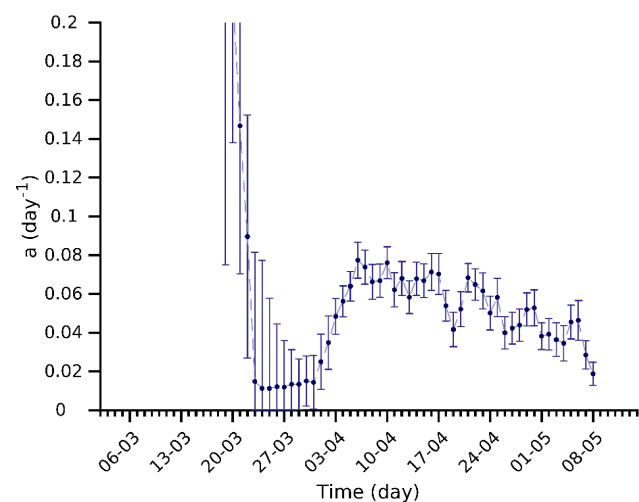
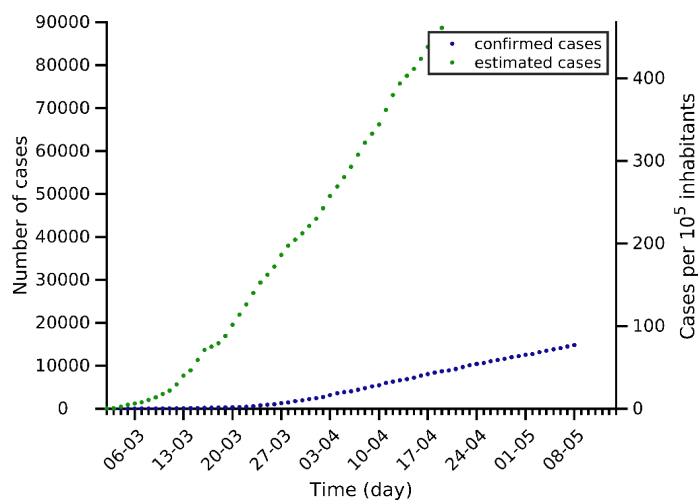
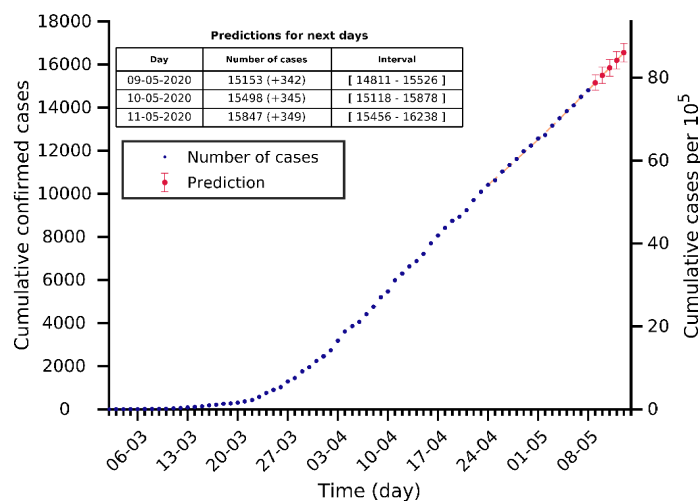
# Austria 08-05-2020. Population: 9.0M. Current cumulated incidence: 175/10<sup>5</sup>



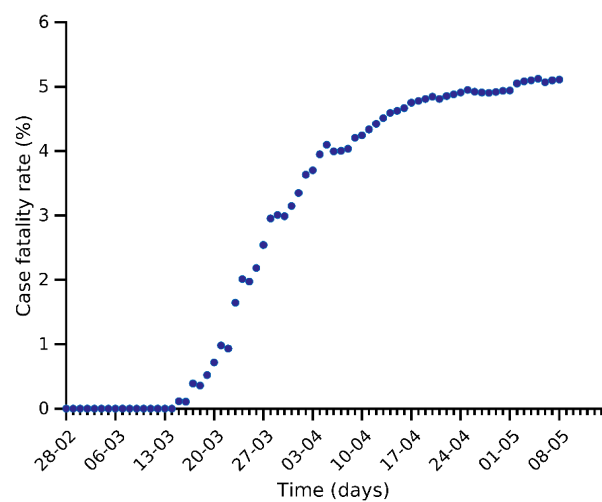
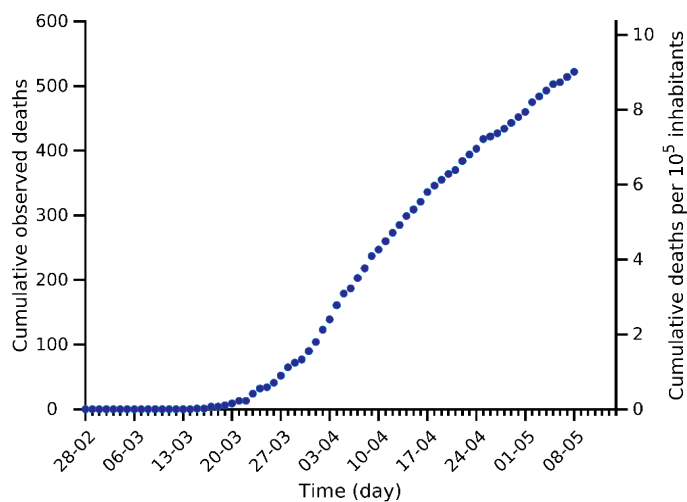
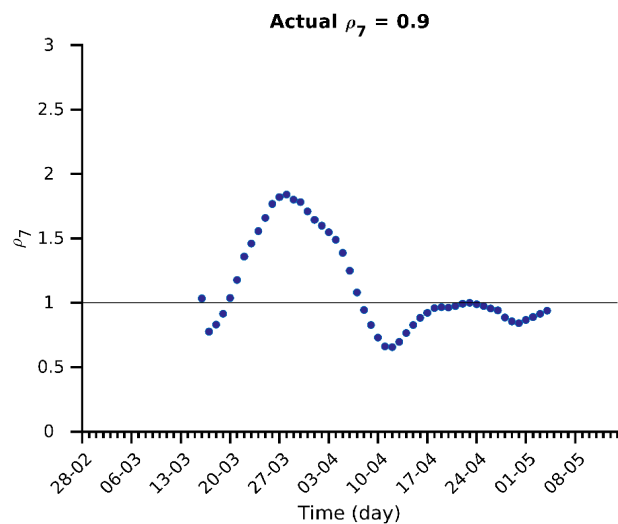
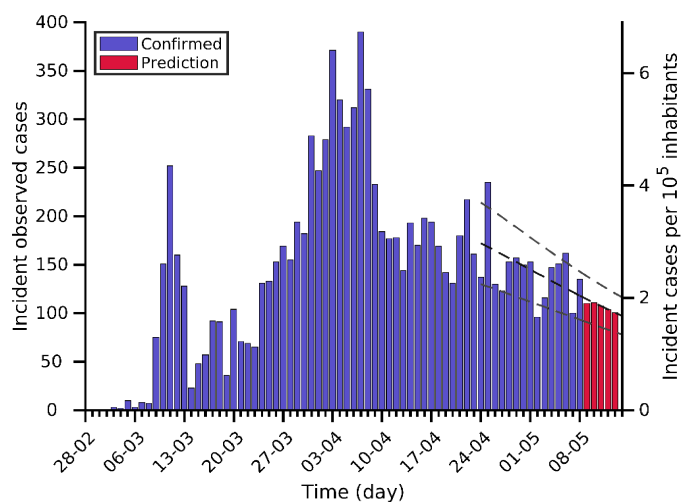
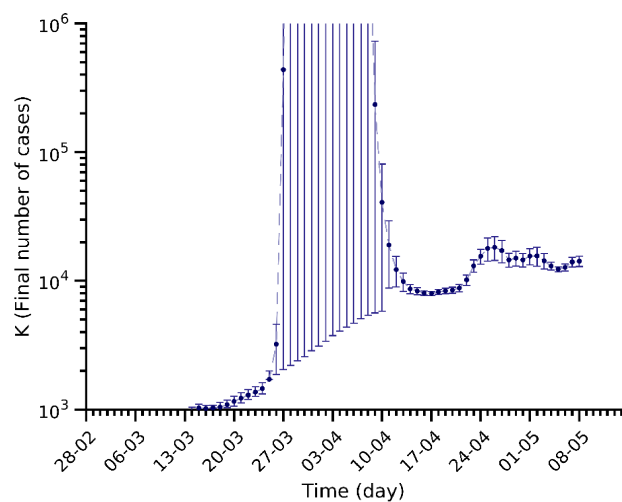
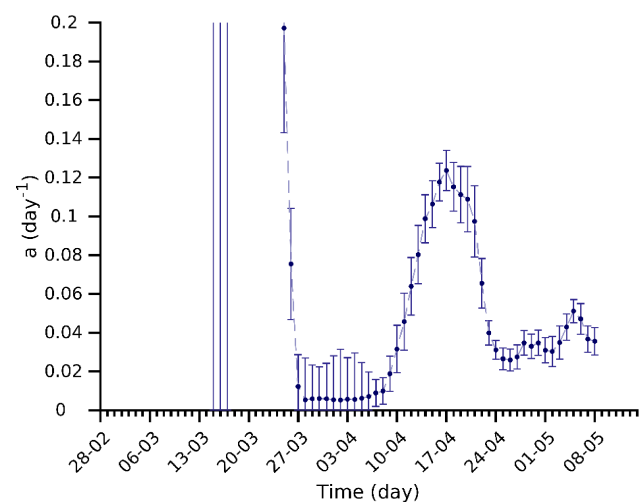
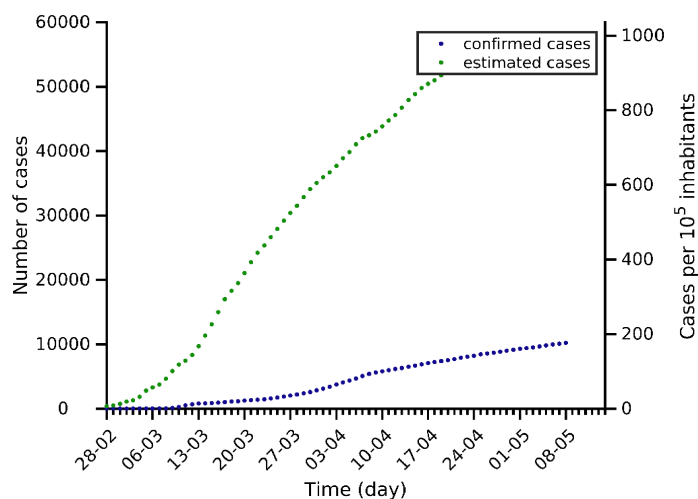
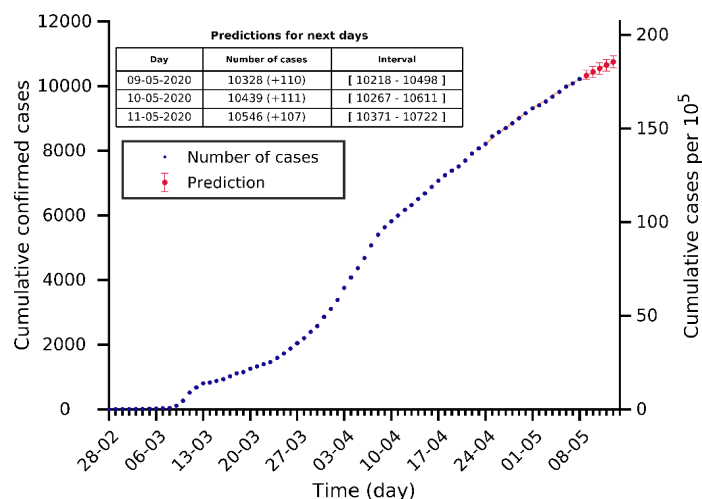
# Poland 08-05-2020. Population: 37.8M. Current cumulated incidence: 41/10<sup>5</sup>



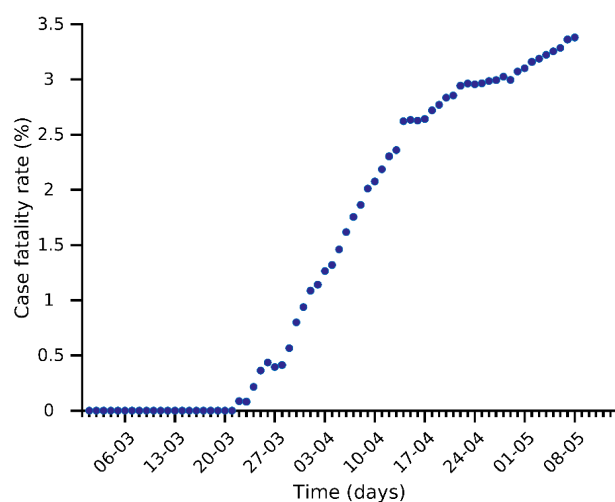
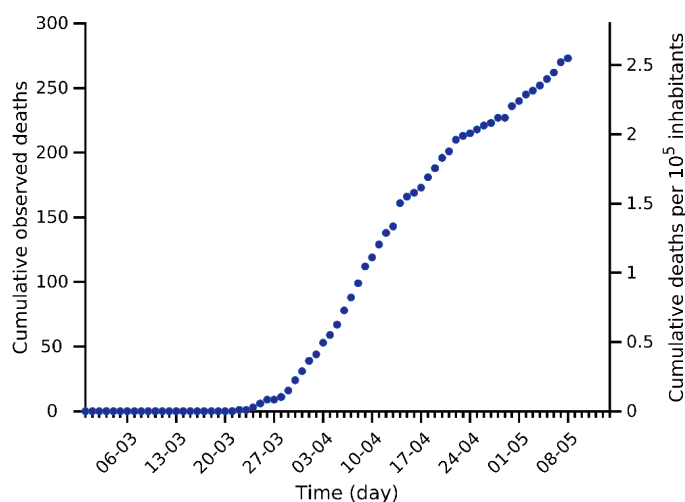
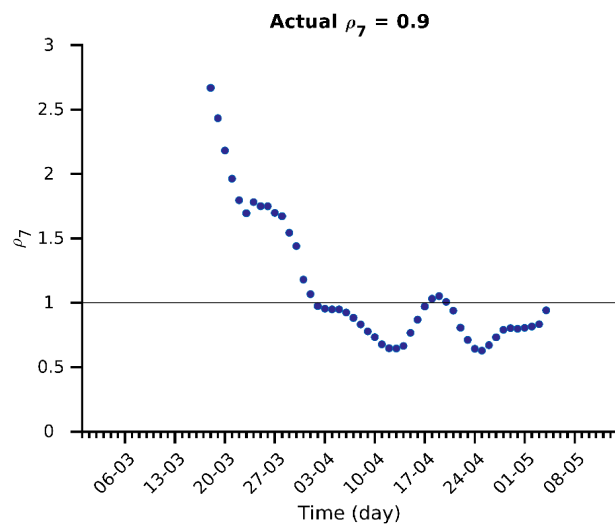
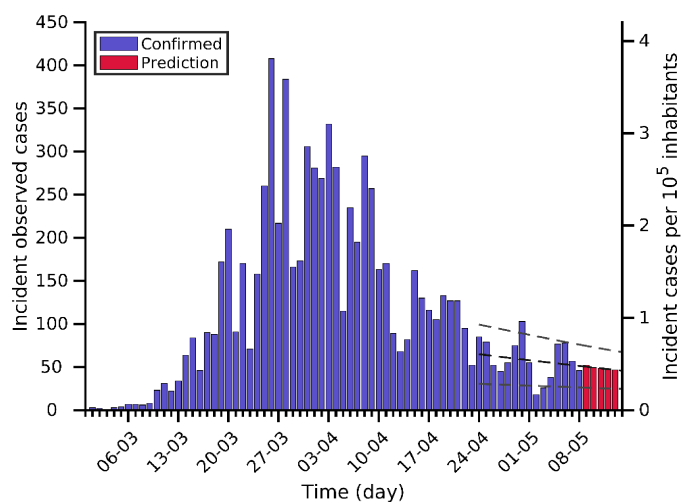
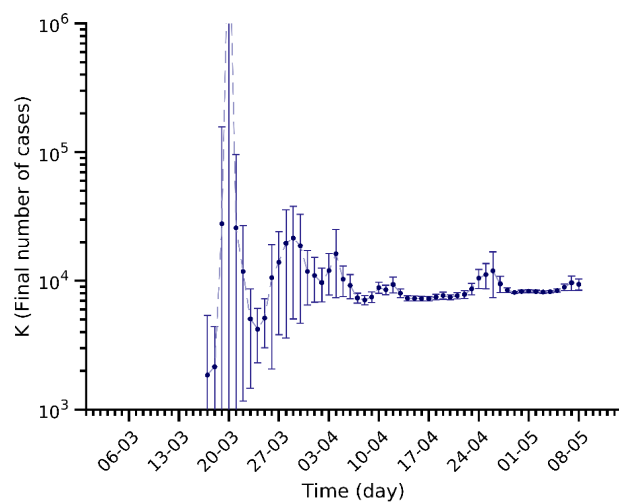
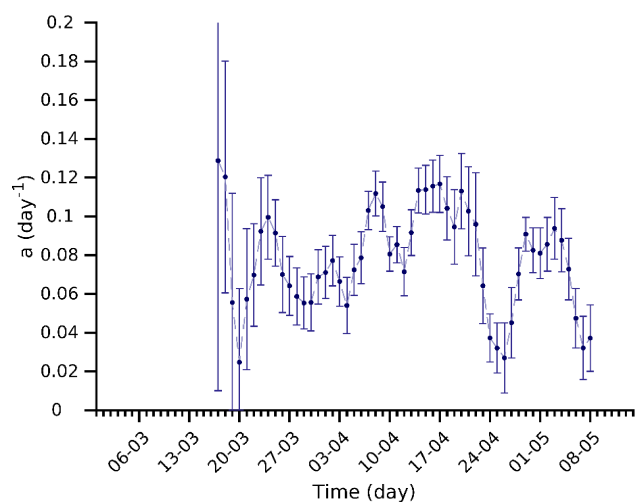
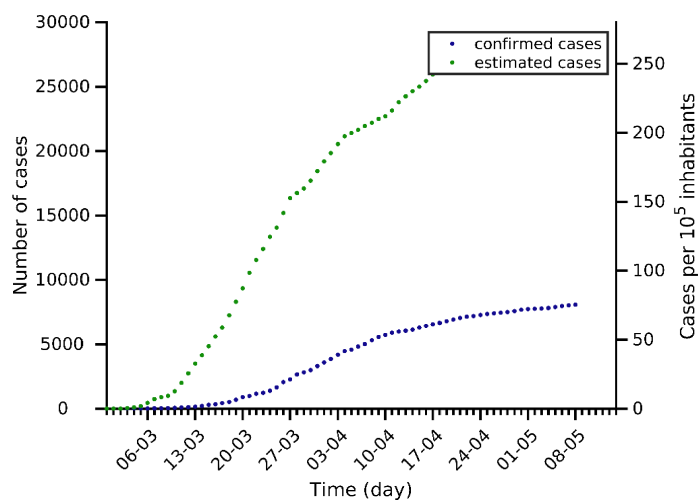
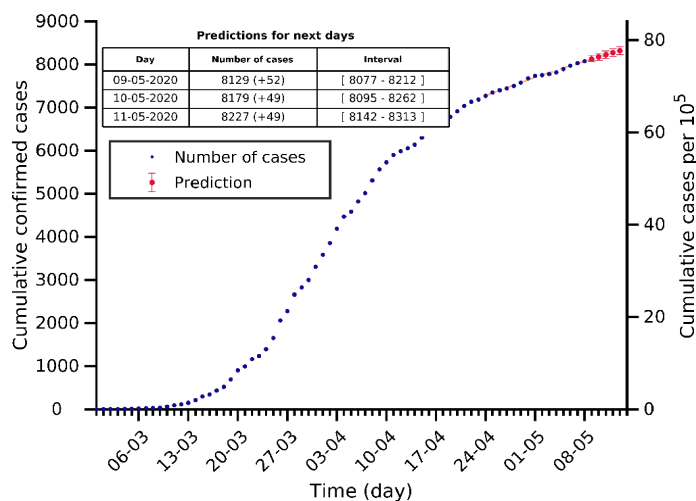
# Romania 08-05-2020. Population: 19.2M. Current cumulated incidence: 77/10<sup>5</sup>



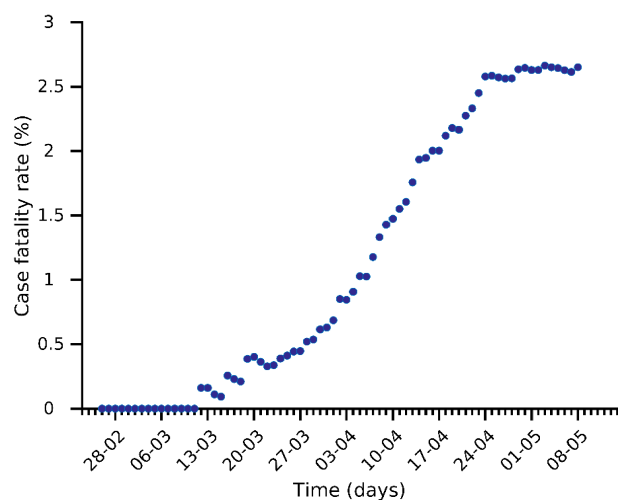
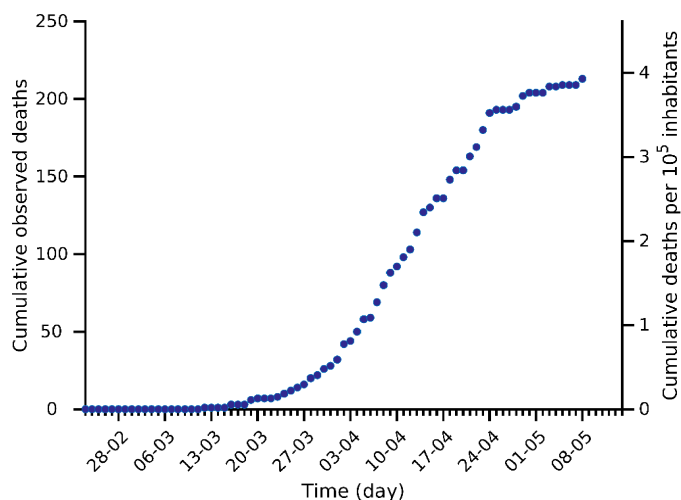
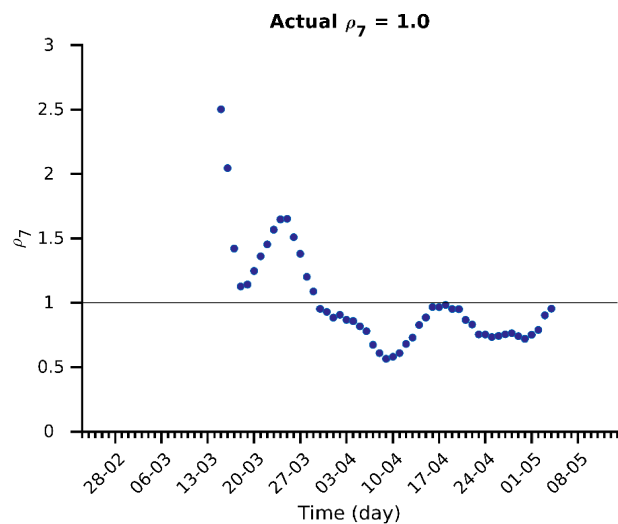
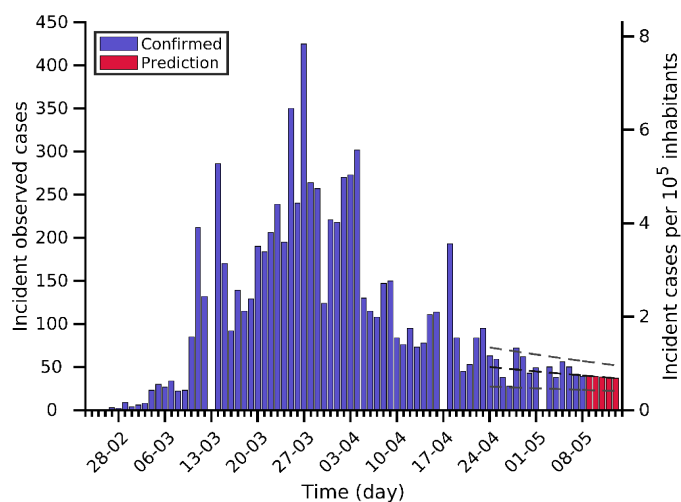
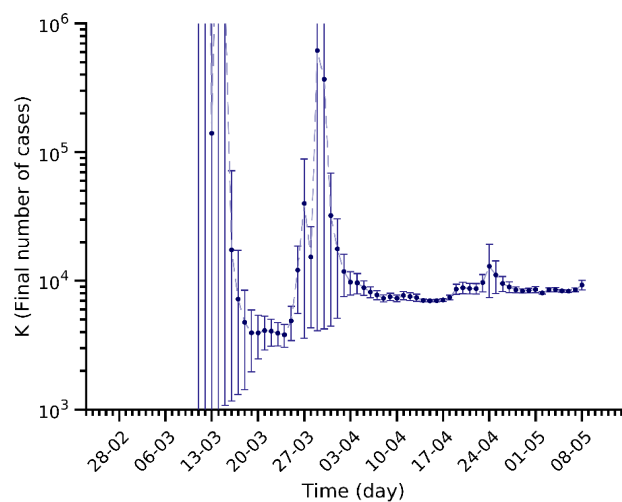
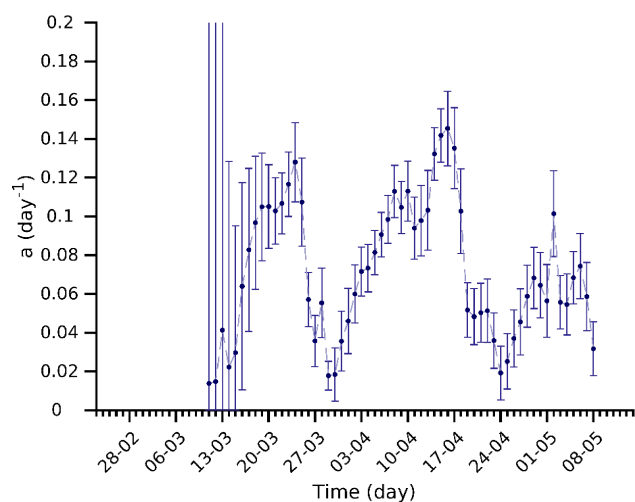
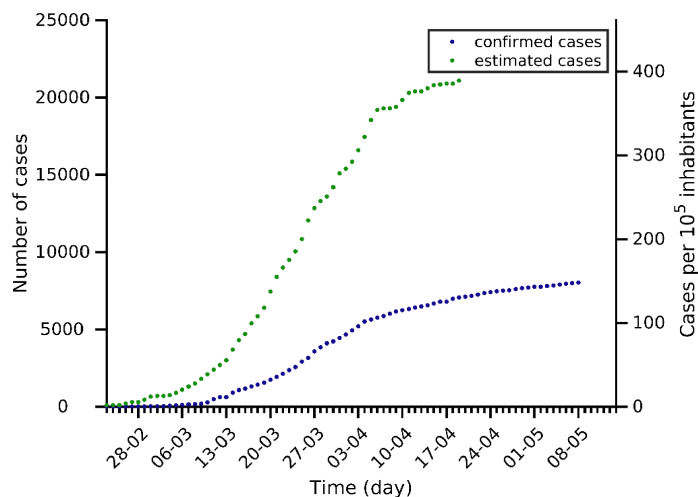
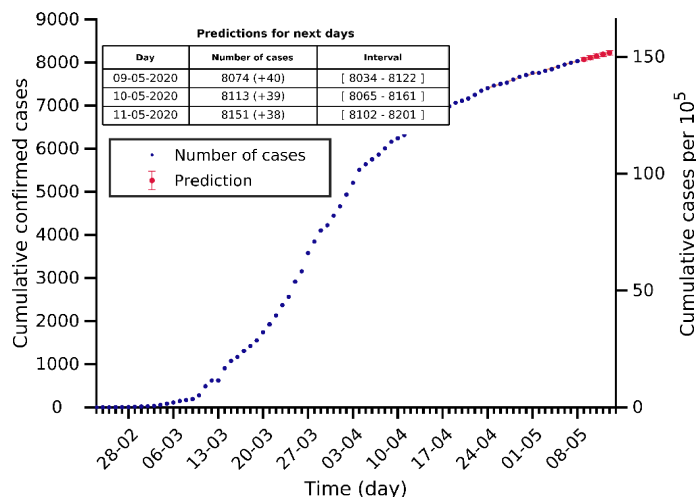
# Denmark 08-05-2020. Population: 5.8M. Current cumulated incidence: 176/10<sup>5</sup>



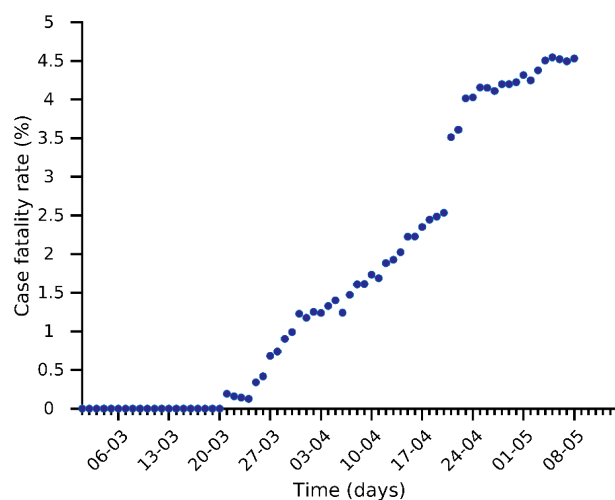
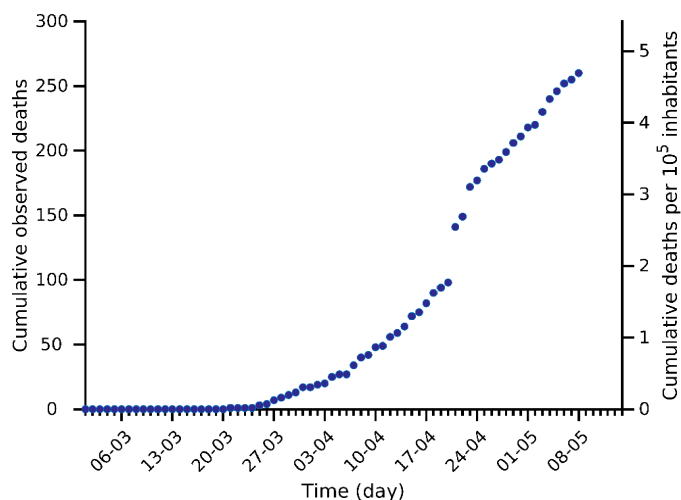
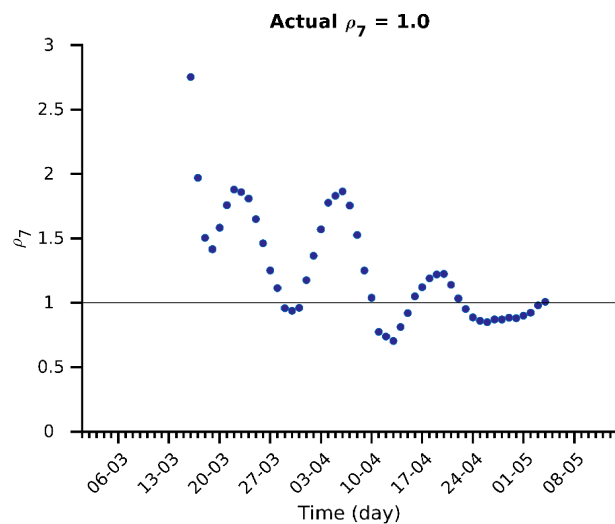
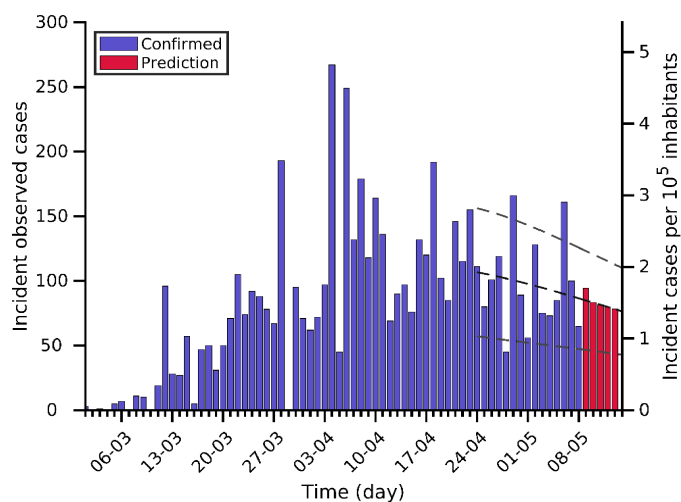
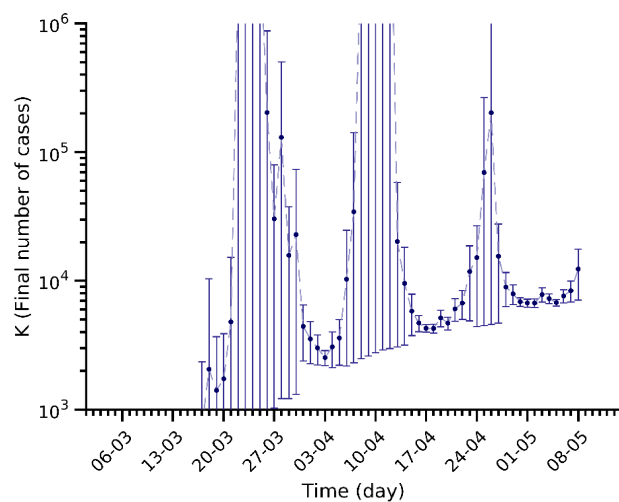
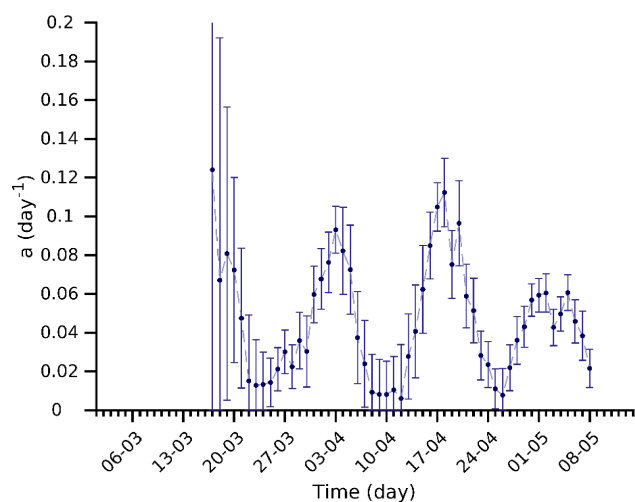
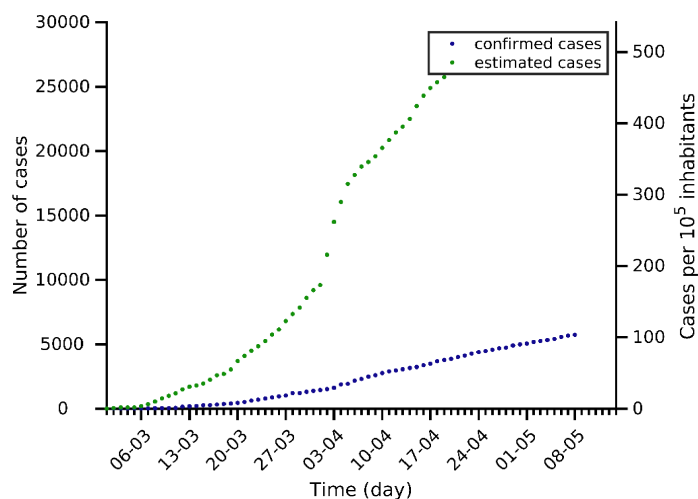
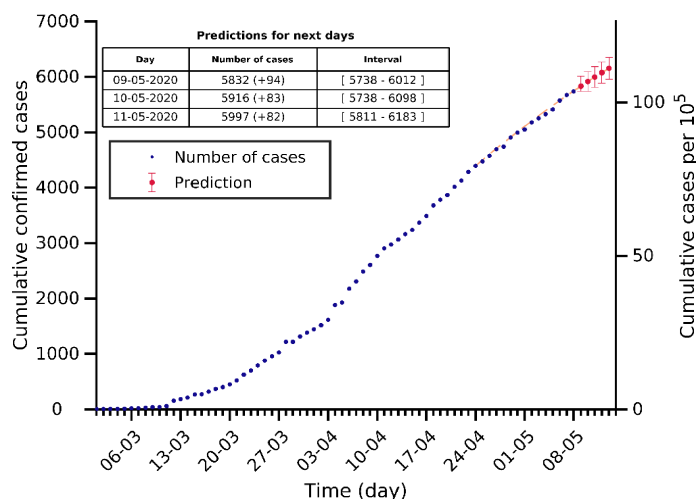
# Czech Rep 08-05-2020. Population: 10.7M. Current cumulated incidence: 75/10<sup>5</sup>



# Norway 08-05-2020. Population: 5.4M. Current cumulated incidence: 148/10<sup>5</sup>

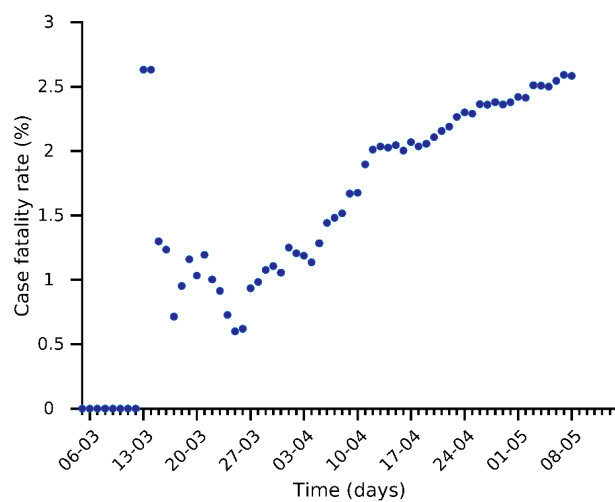
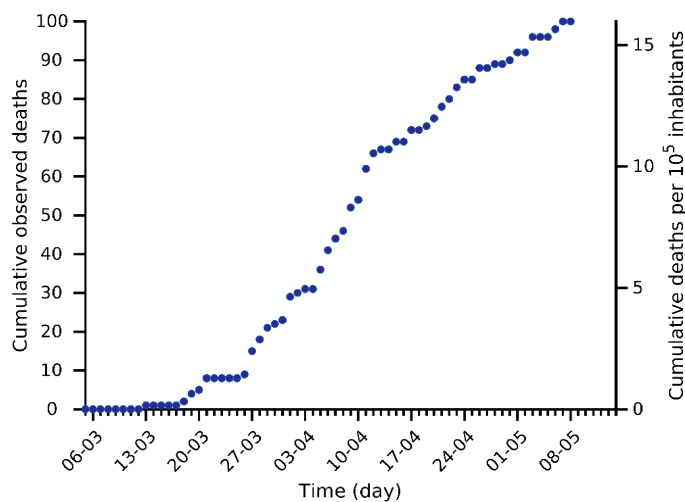
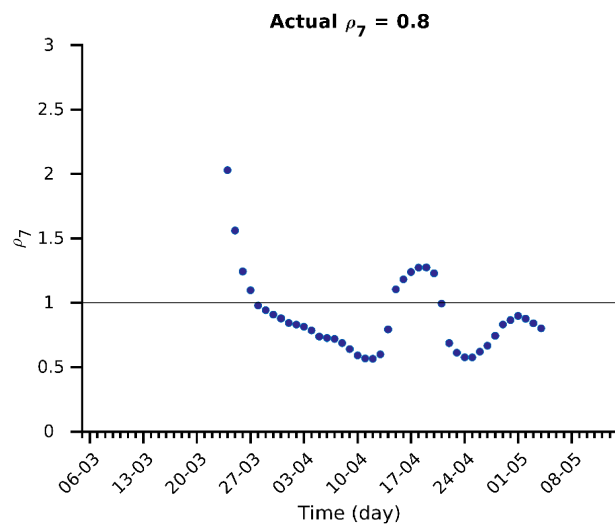
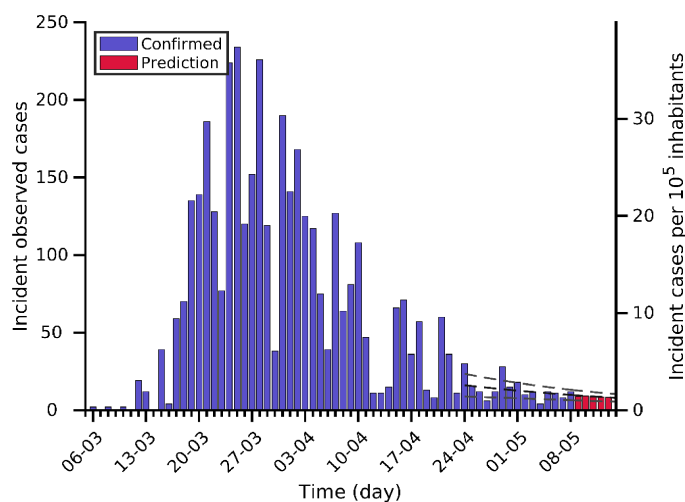
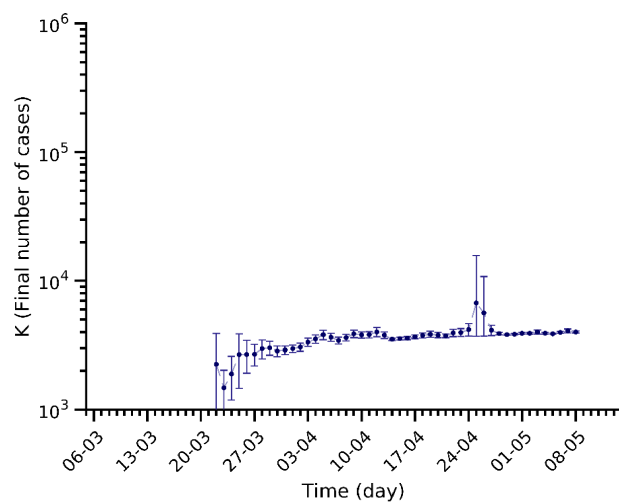
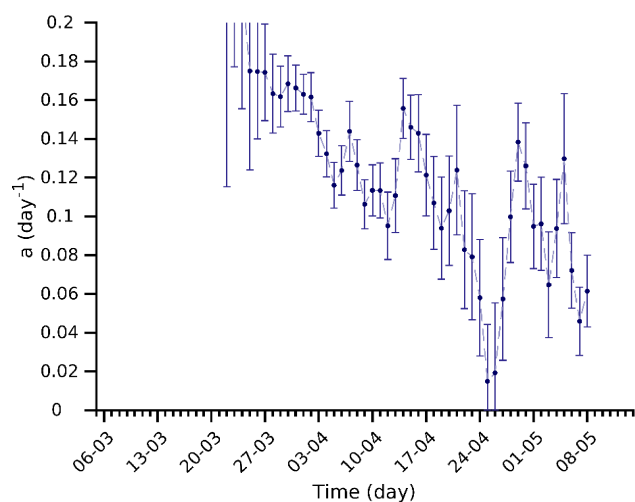
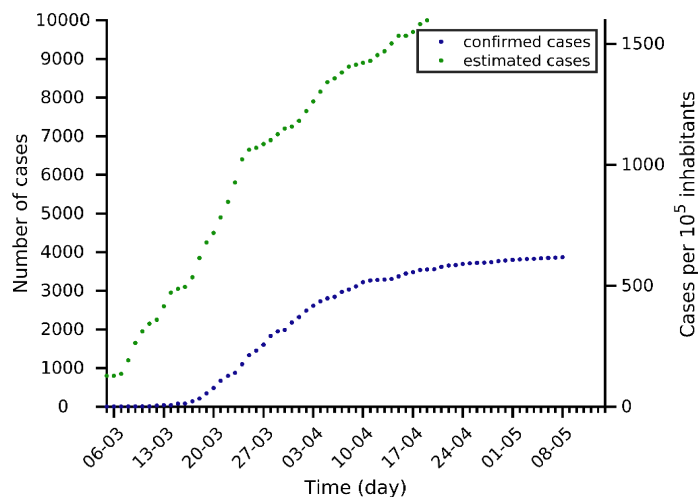
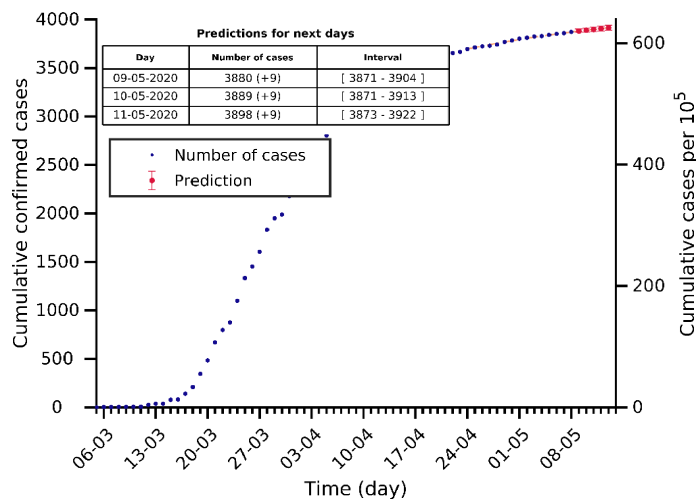


# Finland 08-05-2020. Population: 5.5M. Current cumulated incidence: 104/10<sup>5</sup>

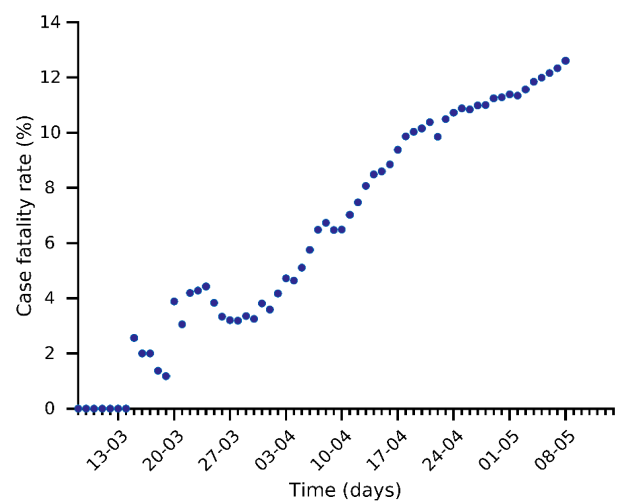
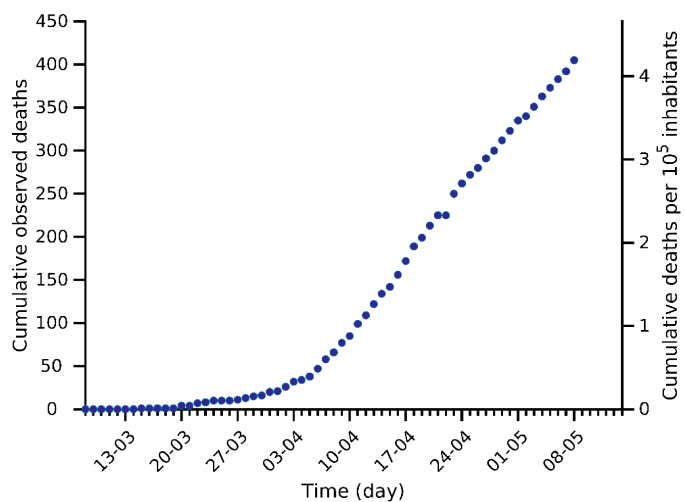
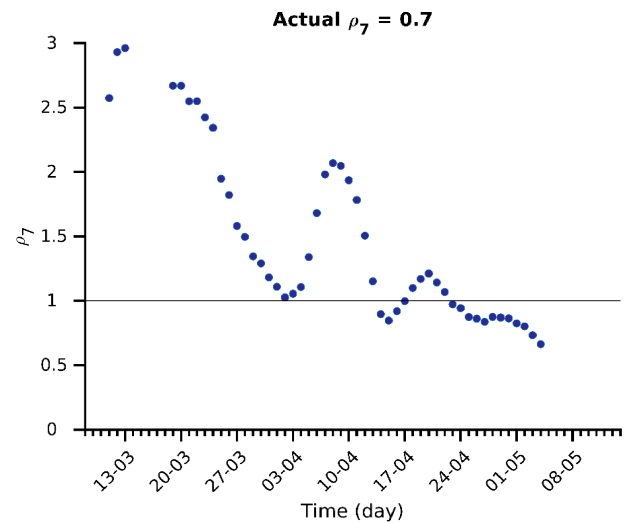
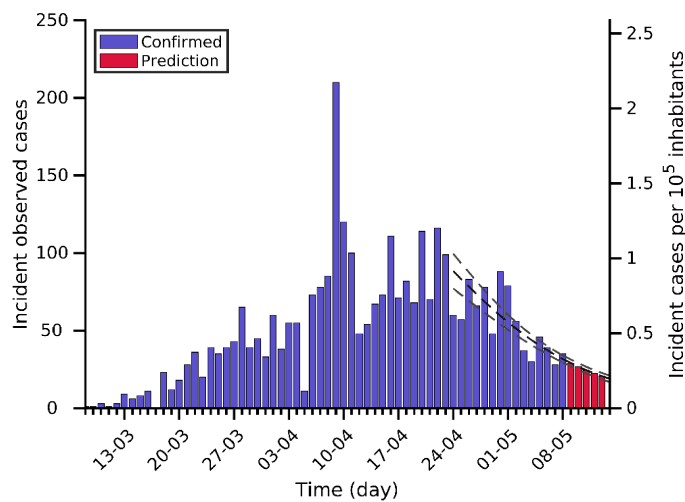
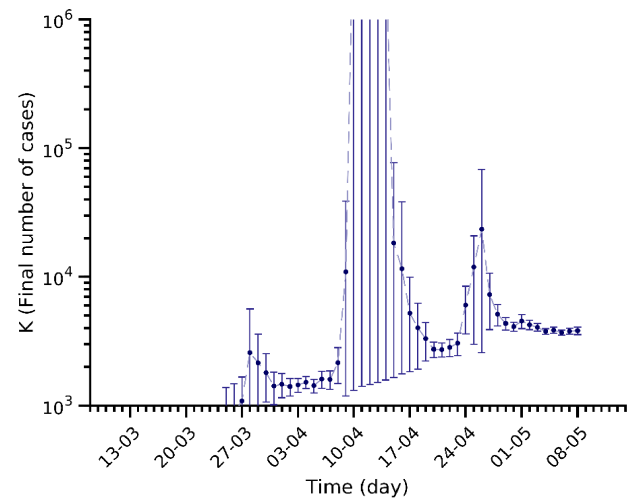
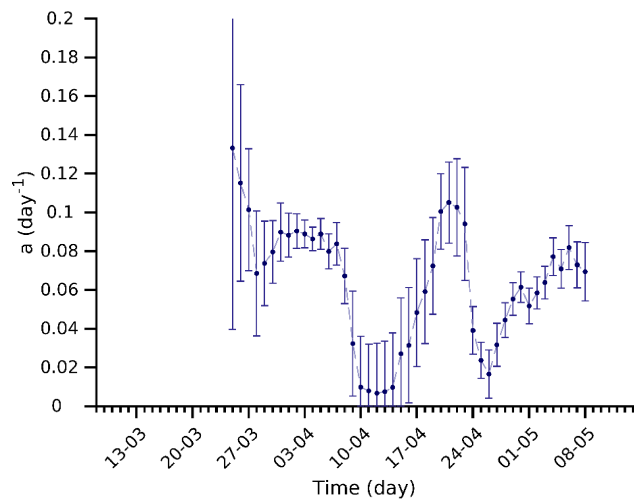
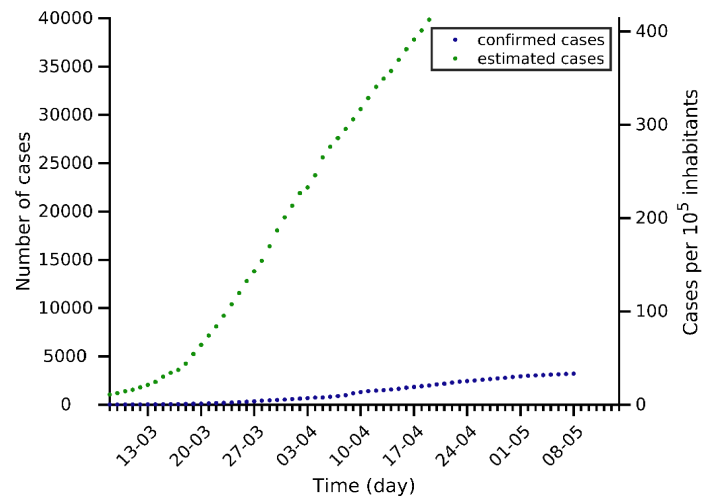
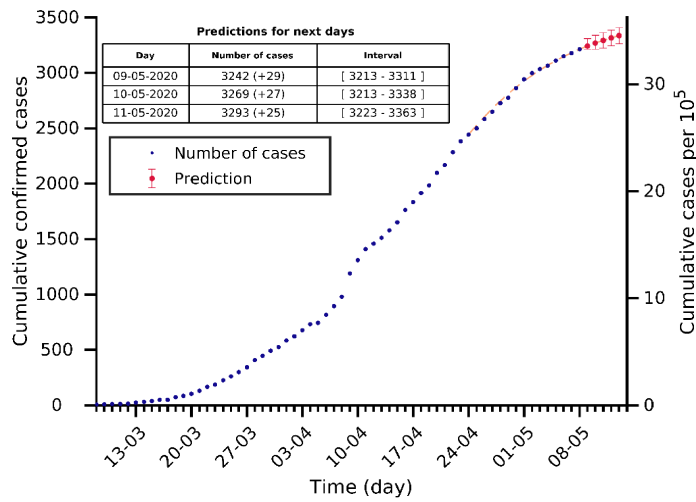




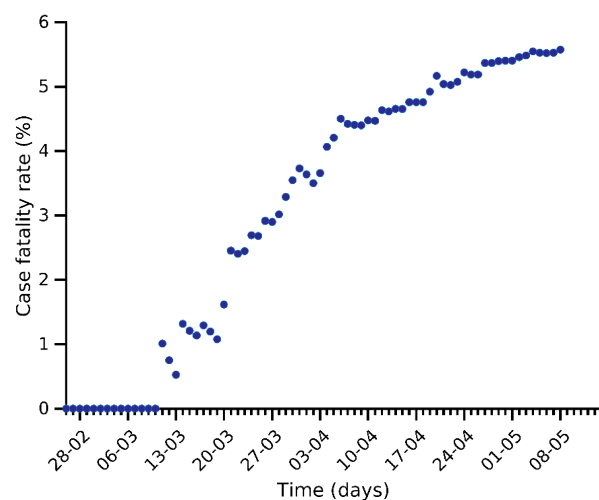
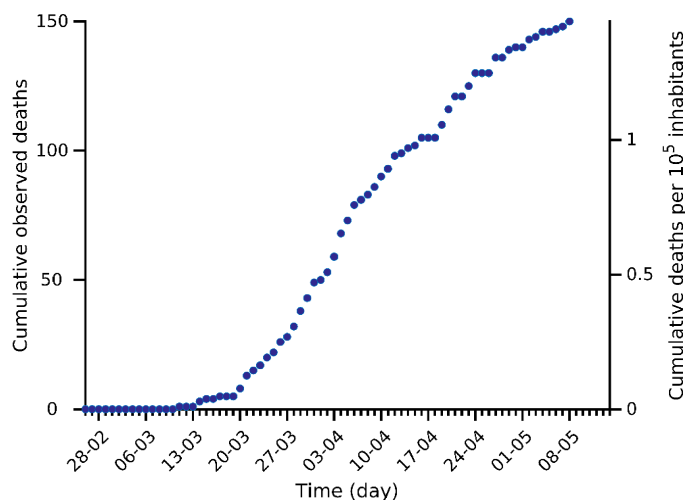
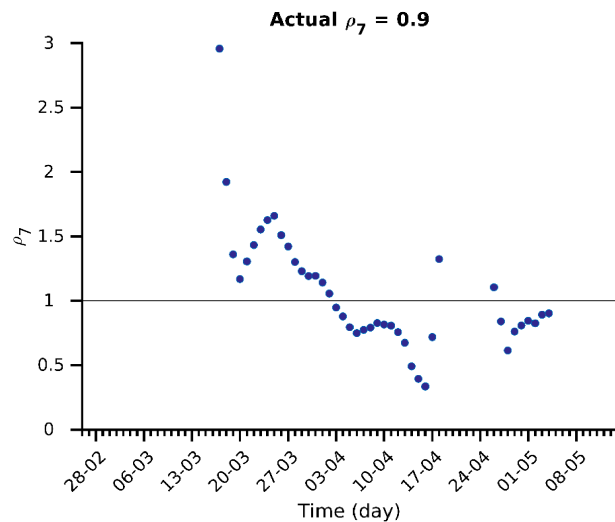
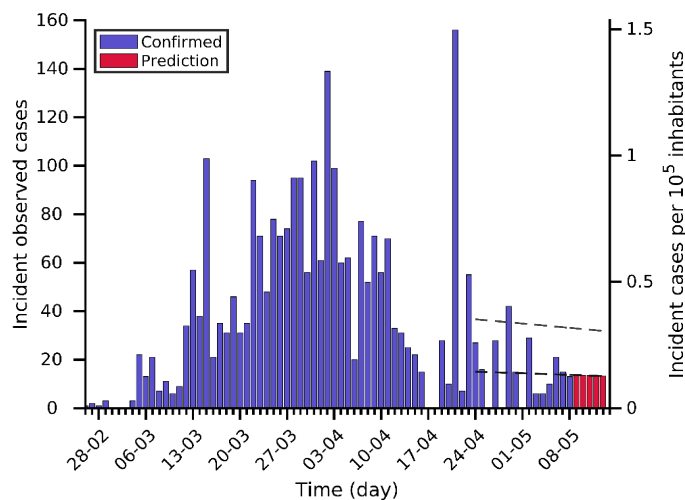
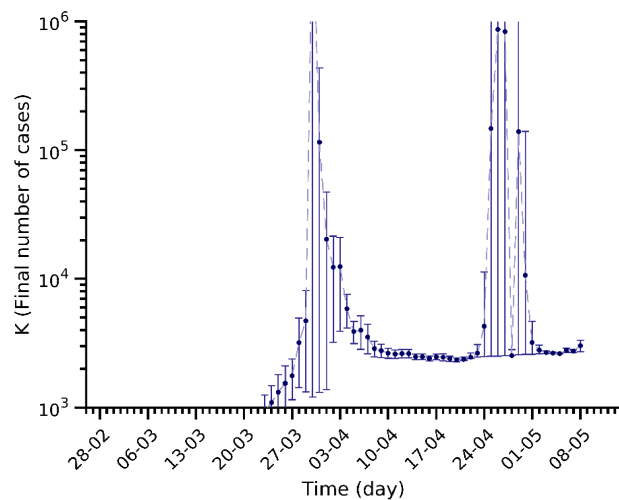
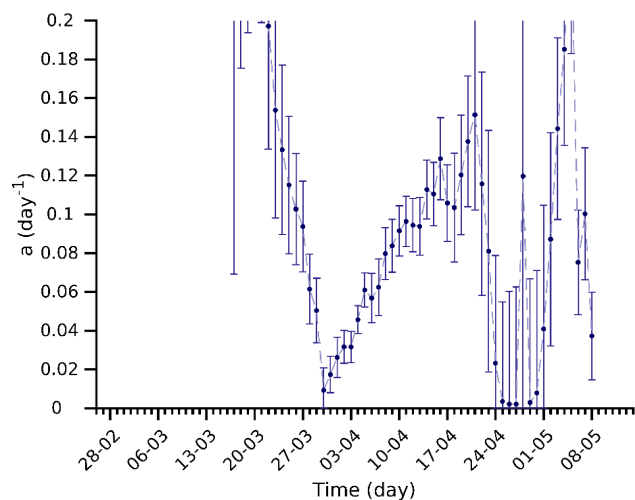
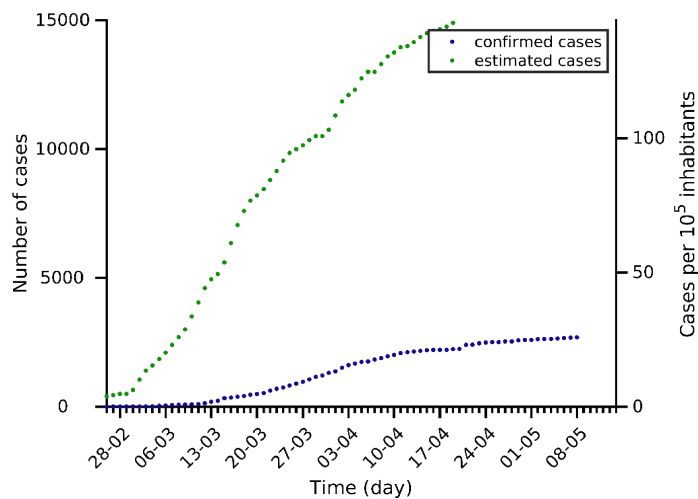
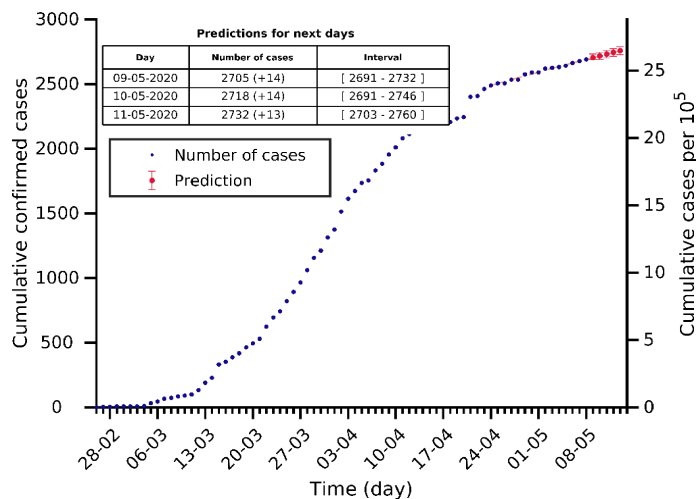
# Luxembourg 08-05-2020. Population: 0.6M. Current cumulated incidence: 618/10<sup>5</sup>



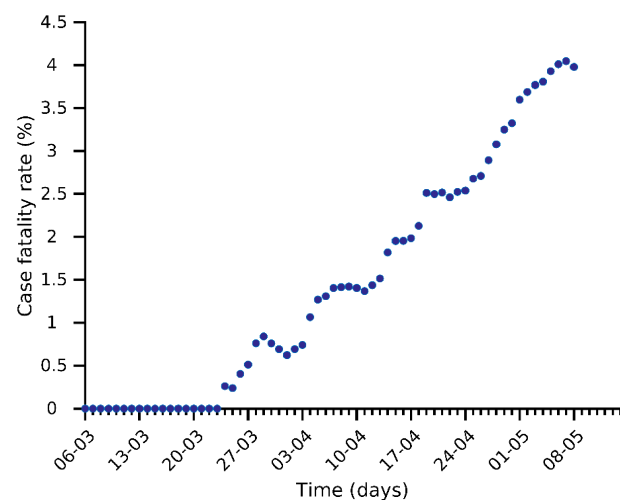
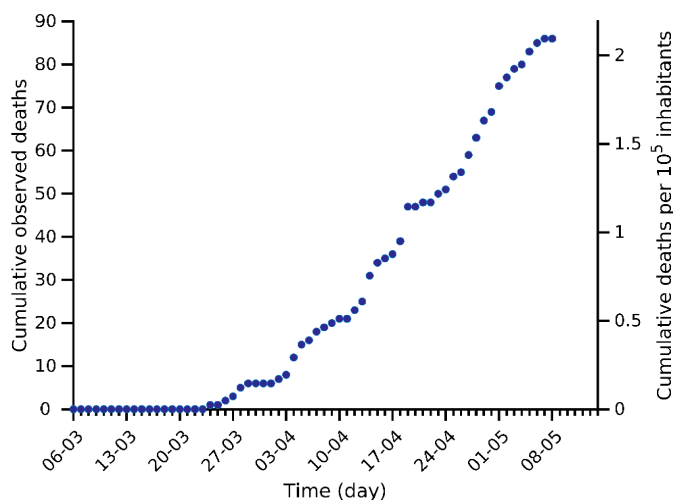
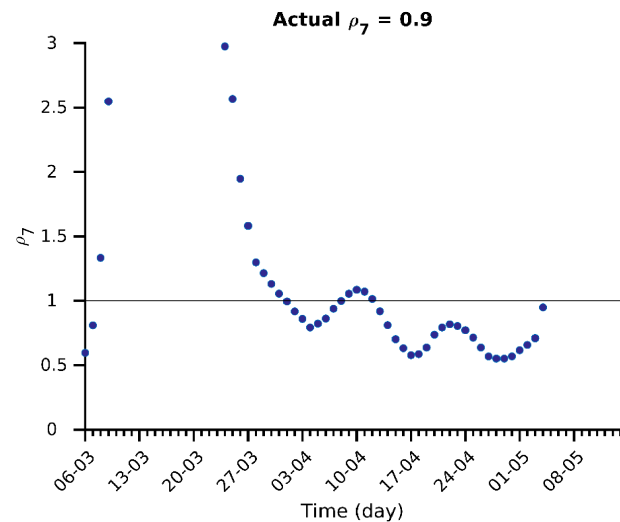
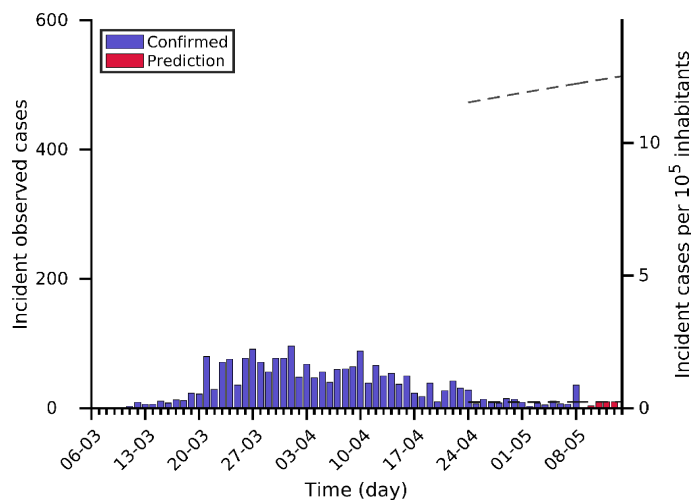
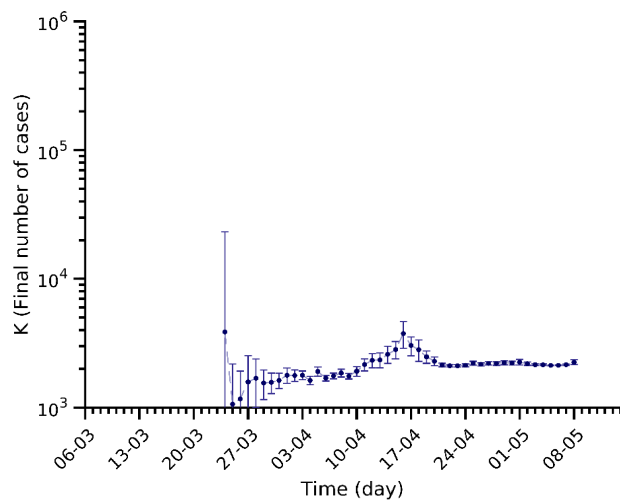
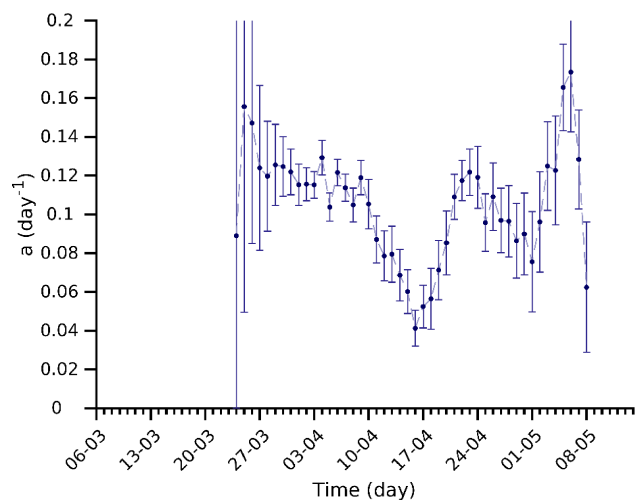
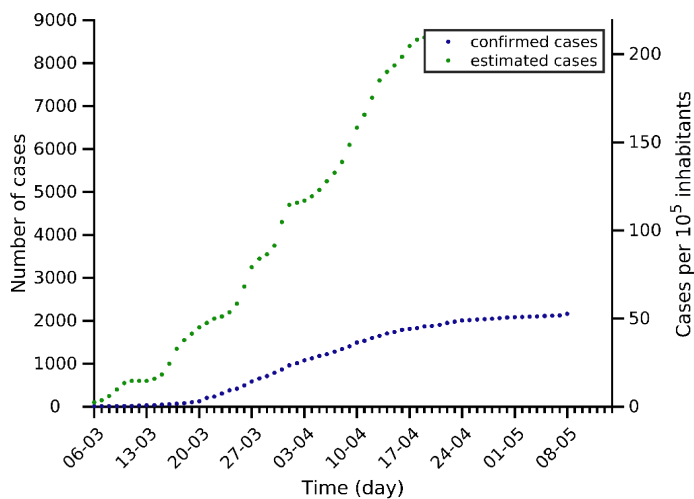
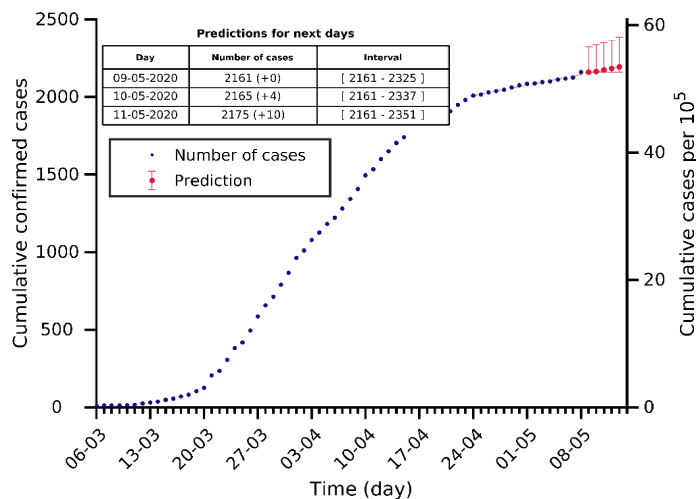
# Hungary 08-05-2020. Population: 9.7M. Current cumulated incidence: 33/10<sup>5</sup>



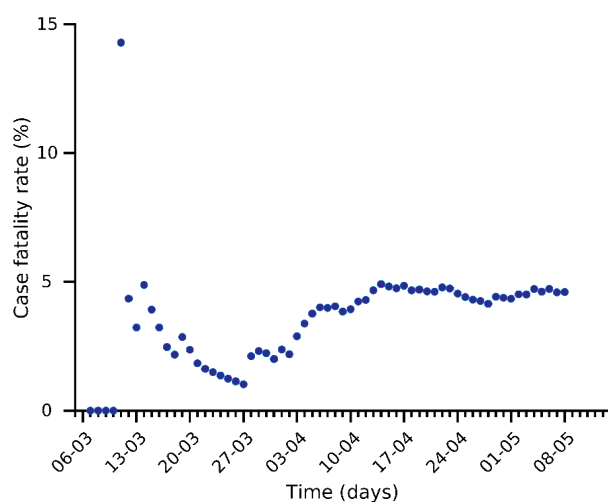
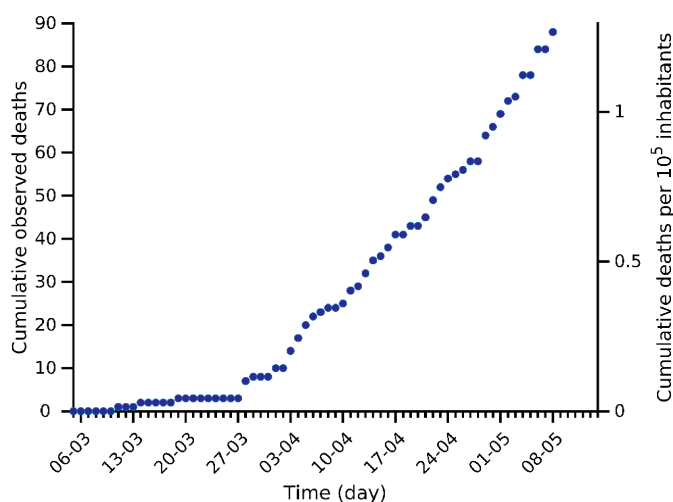
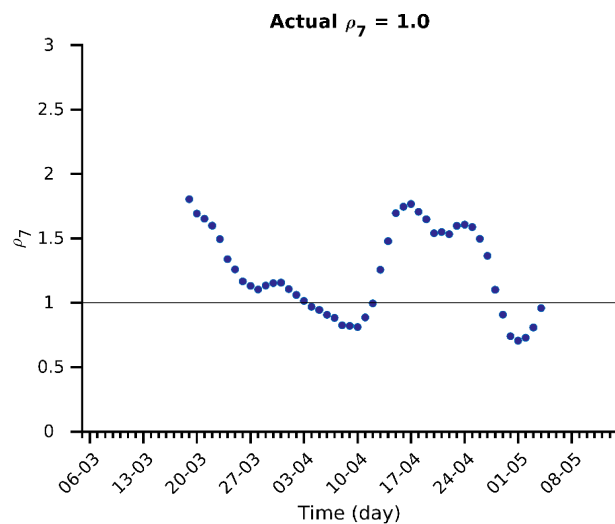
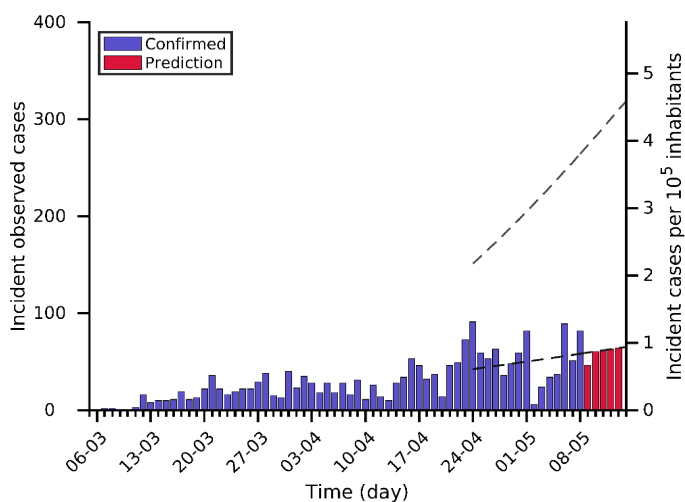
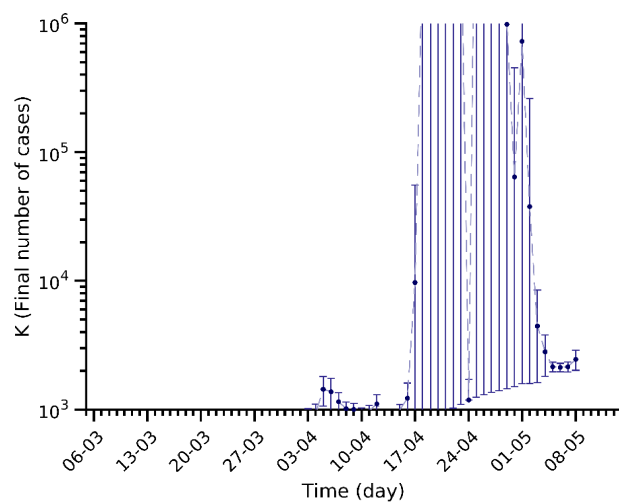
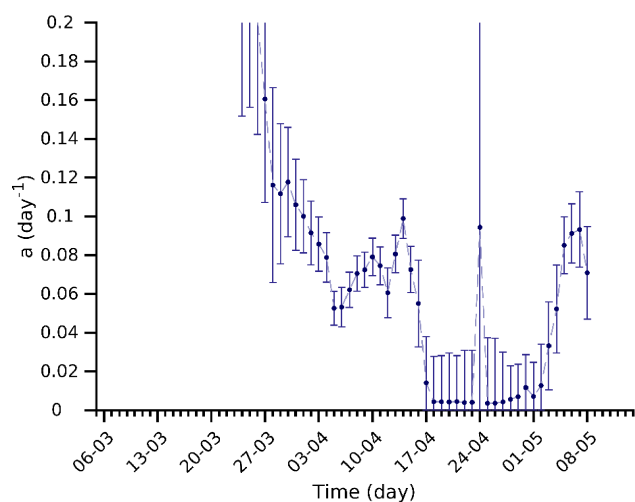
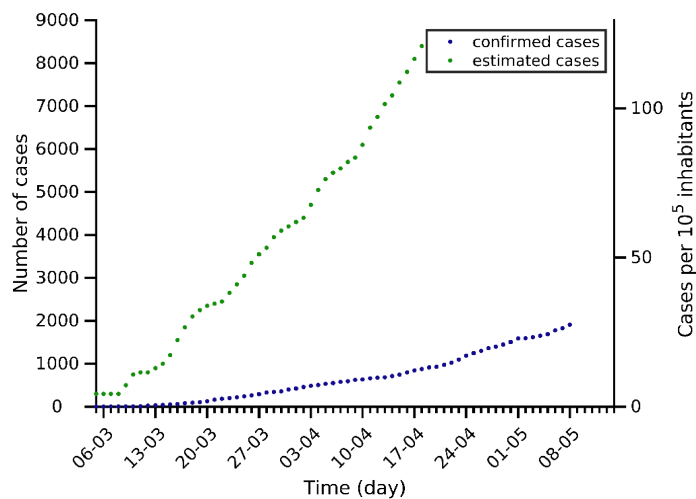
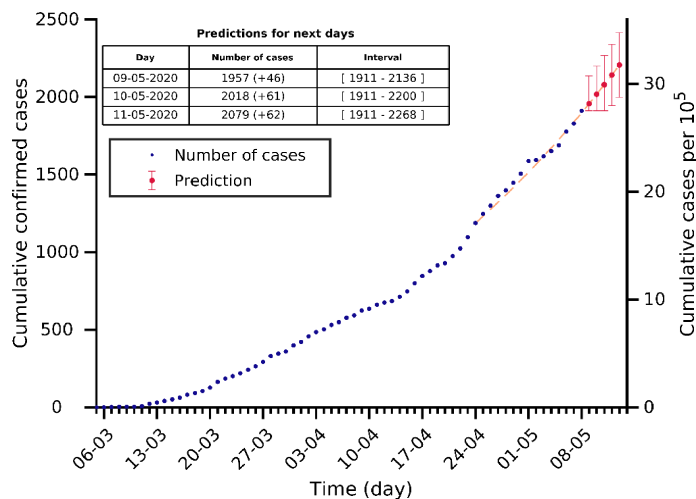
# Greece 08-05-2020. Population: 10.4M. Current cumulated incidence: 26/10<sup>5</sup>



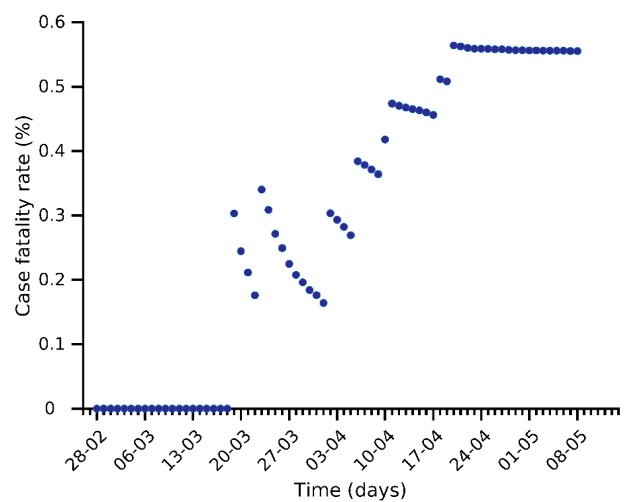
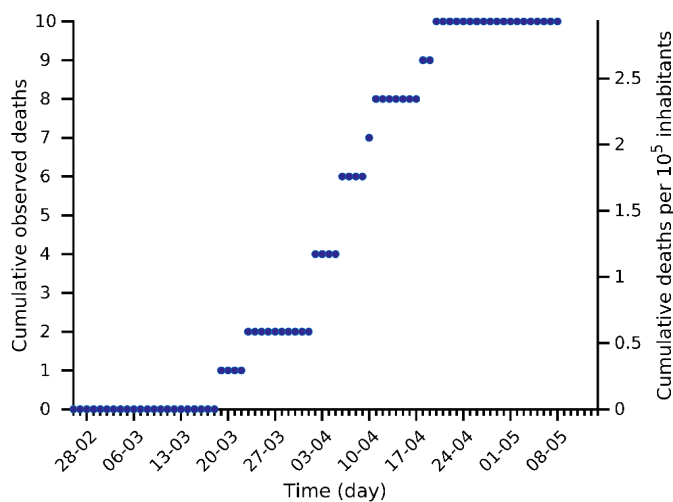
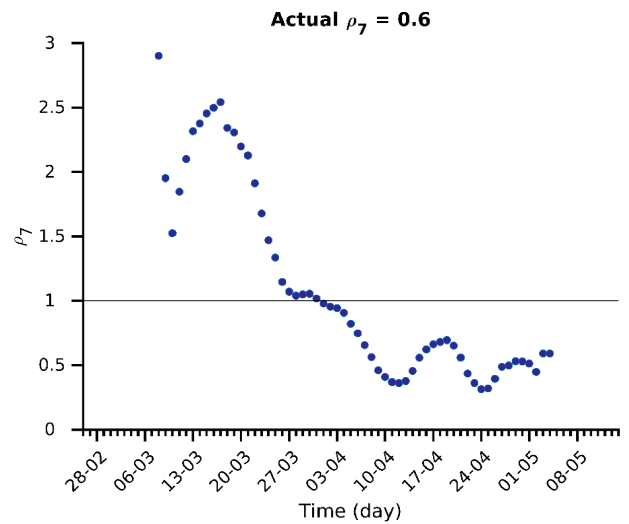
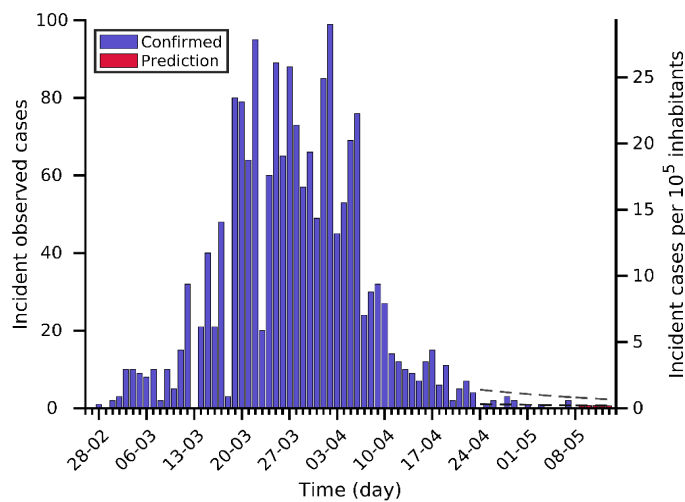
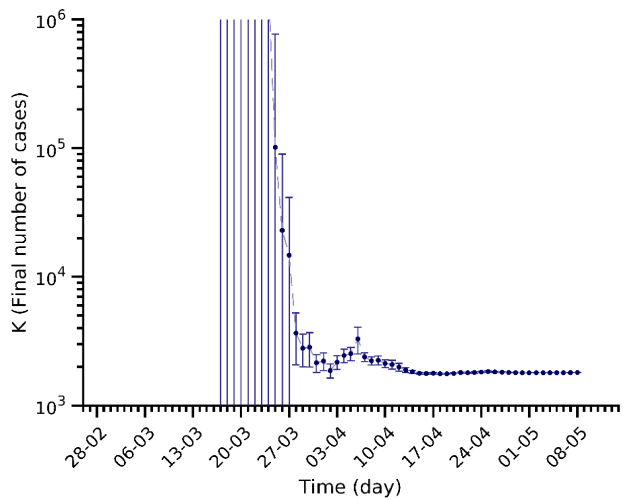
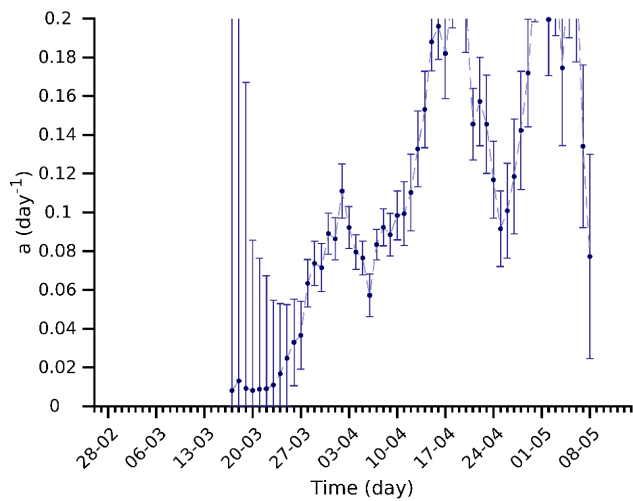
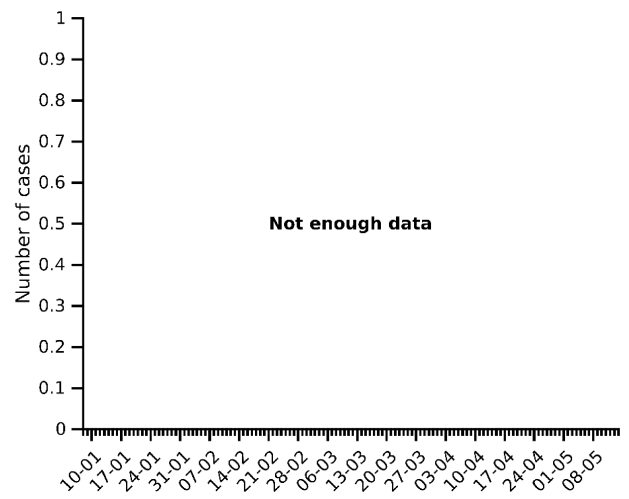
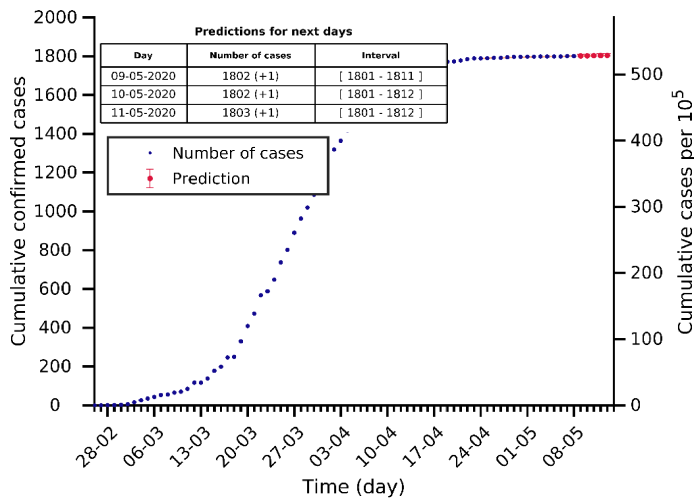
# Croatia 08-05-2020. Population: 4.1M. Current cumulated incidence: 53/10<sup>5</sup>



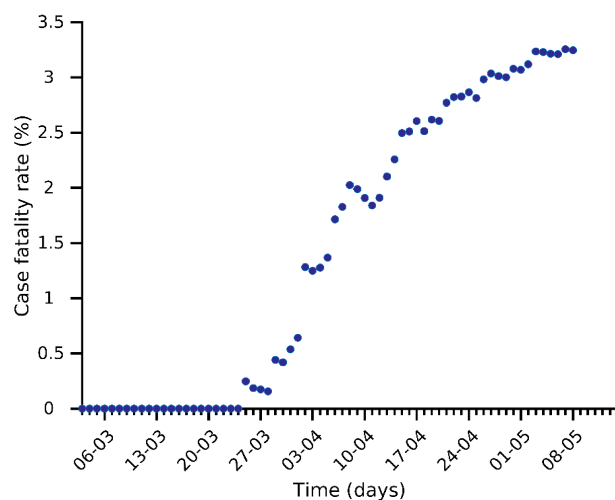
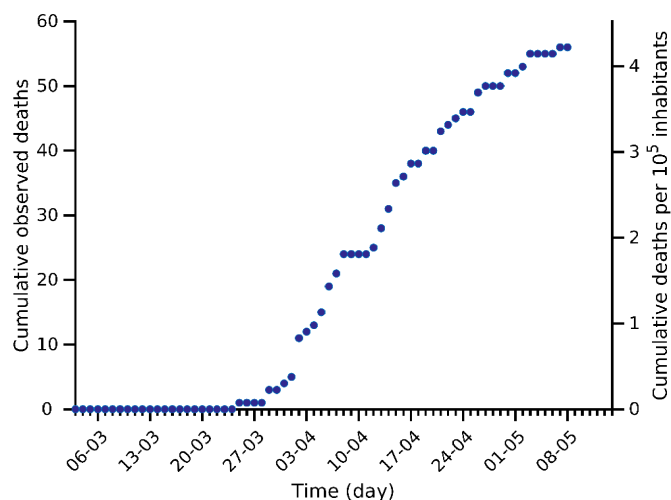
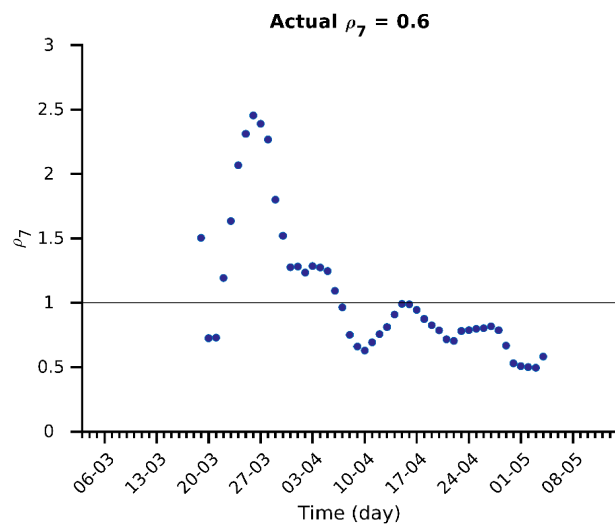
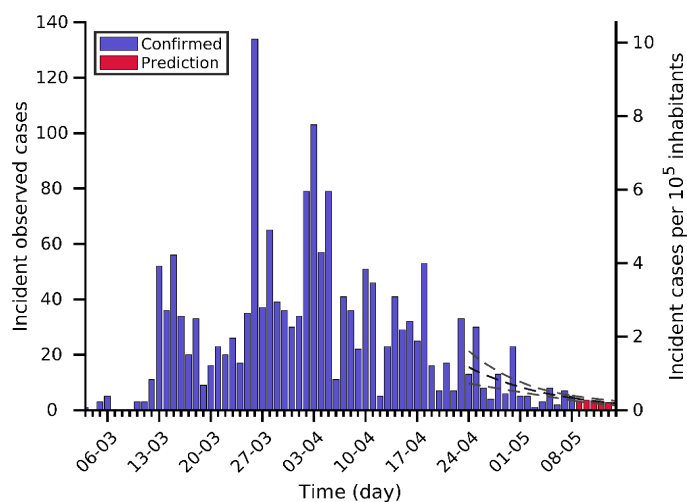
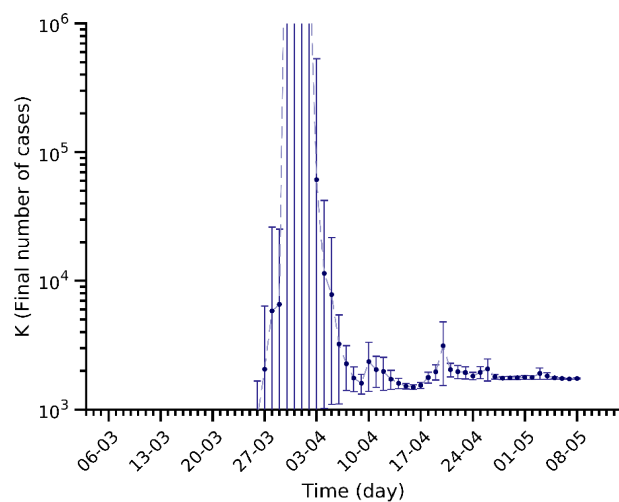
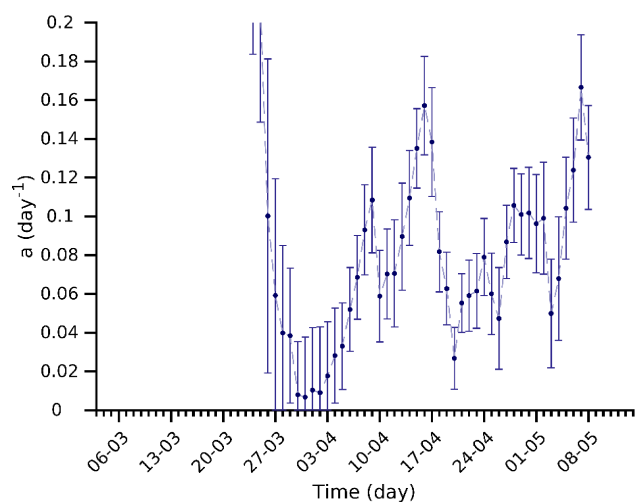
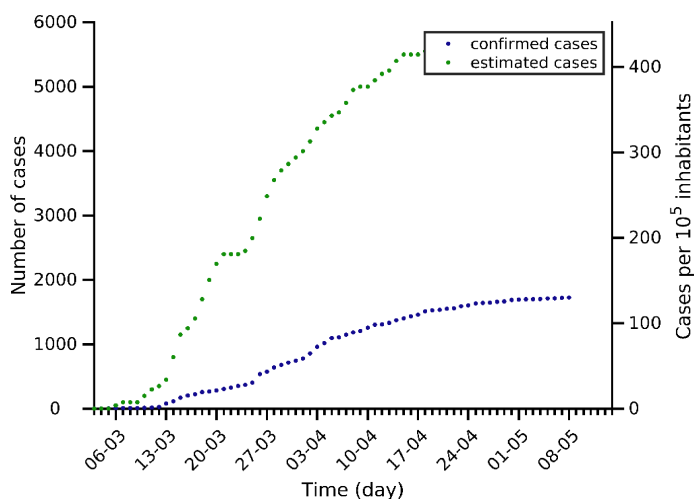
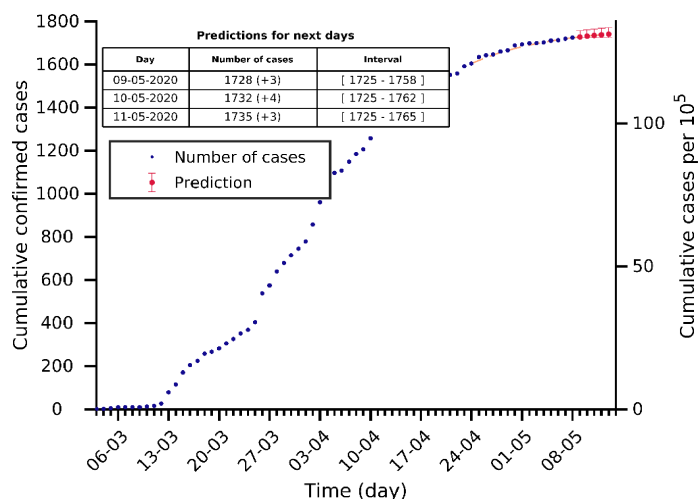
# Bulgaria 08-05-2020. Population: 6.9M. Current cumulated incidence: 28/10<sup>5</sup>



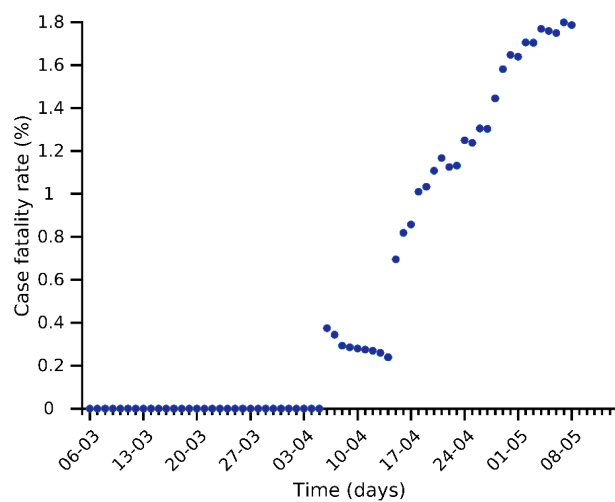
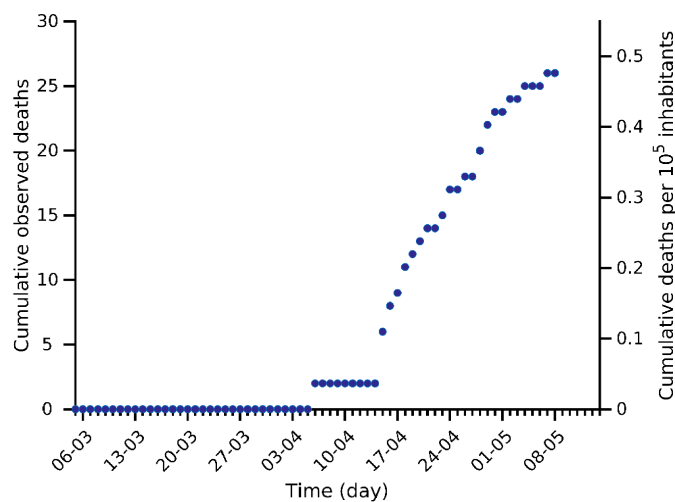
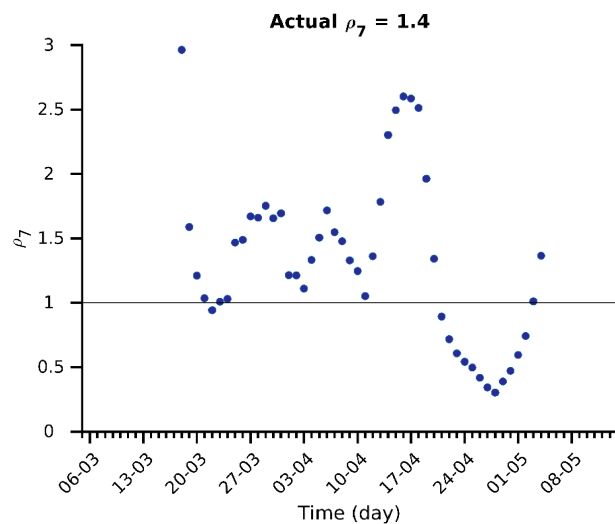
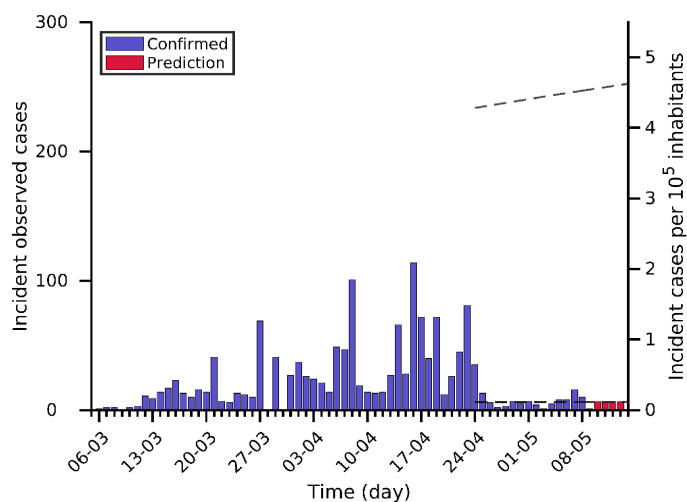
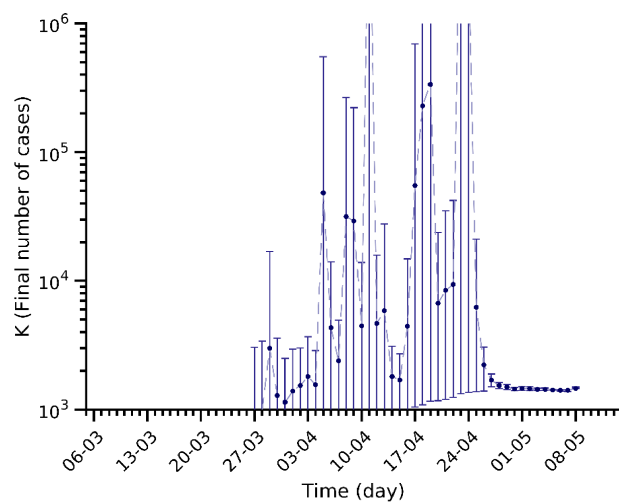
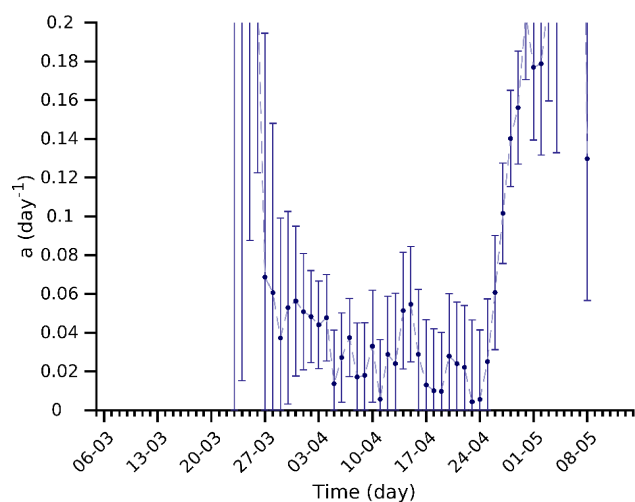
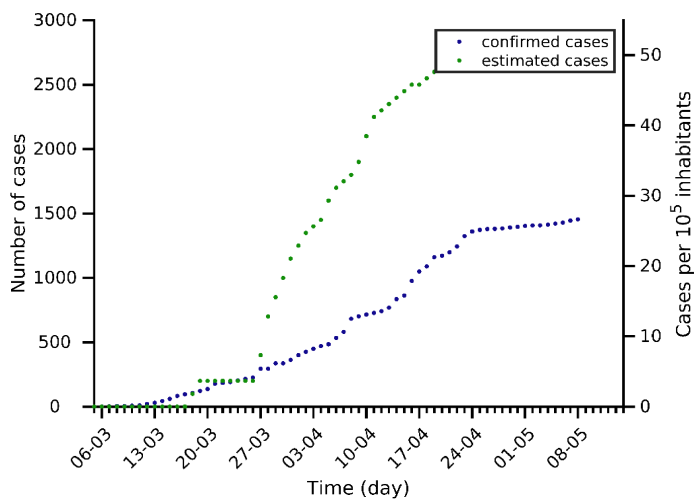
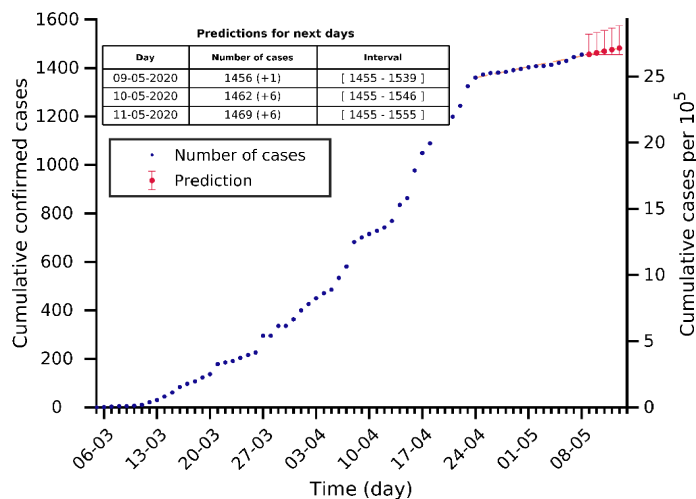
# Iceland 08-05-2020. Population: 0.3M. Current cumulated incidence: 528/10<sup>5</sup>



# Estonia 08-05-2020. Population: 1.3M. Current cumulated incidence: 130/10<sup>5</sup>

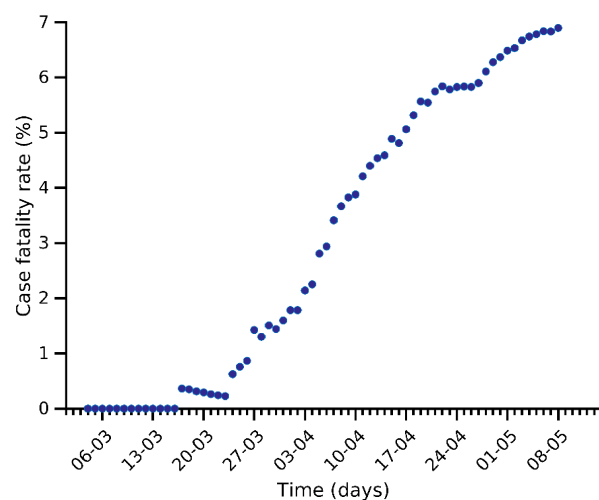
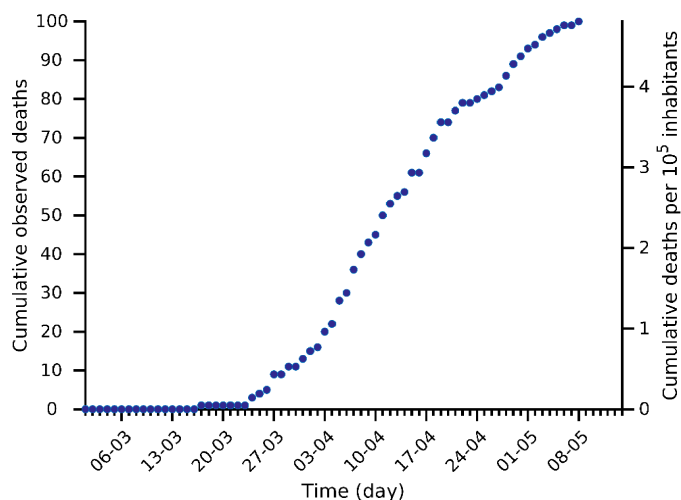
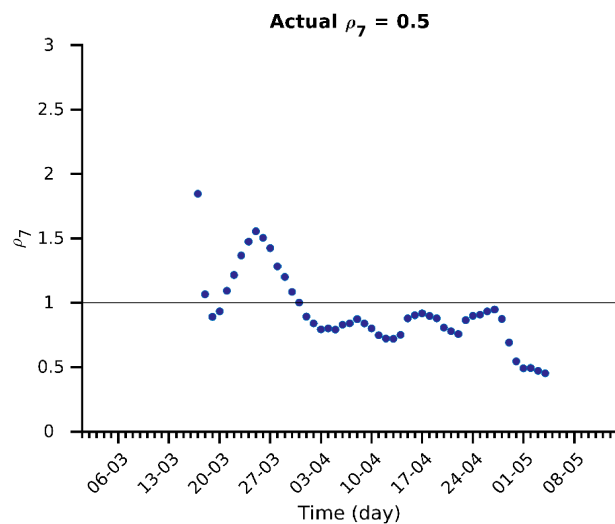
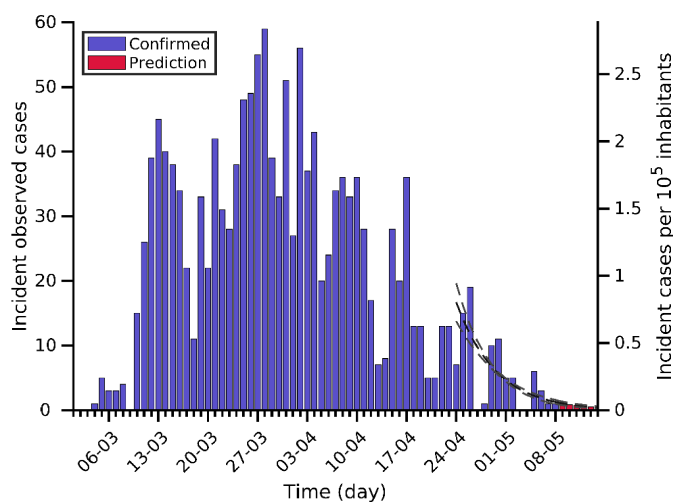
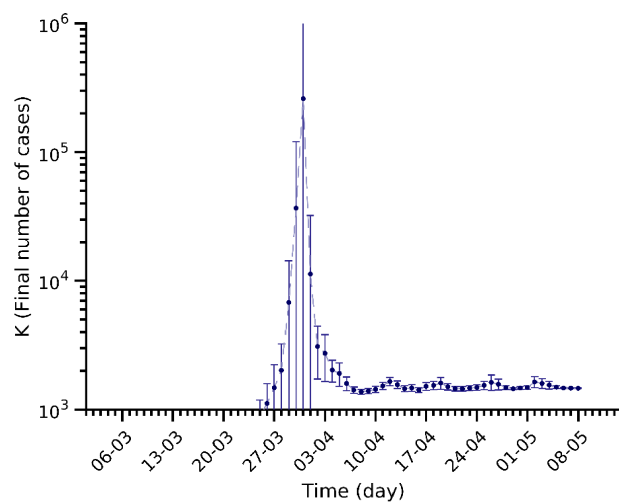
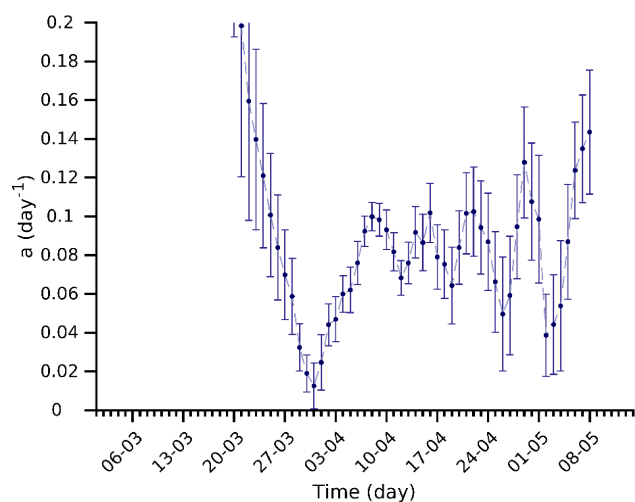
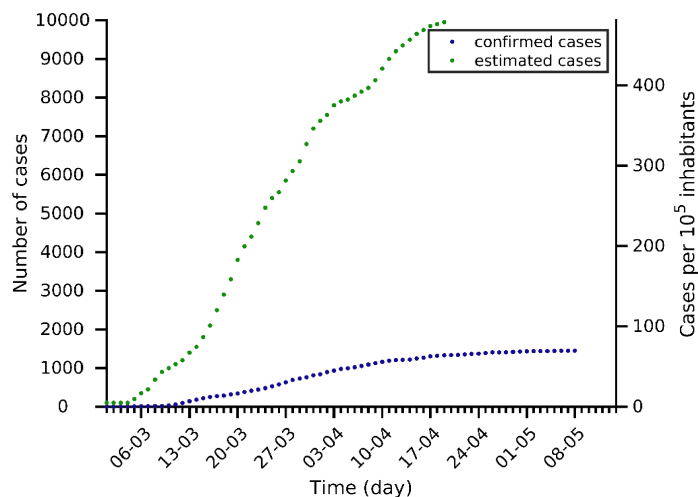
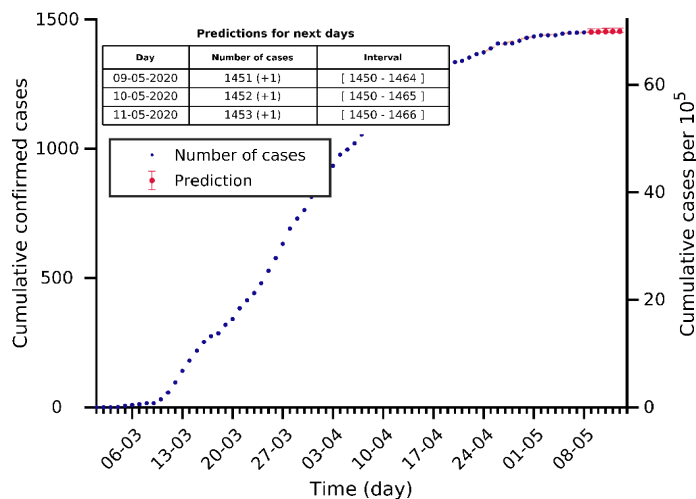


# Slovakia 08-05-2020. Population: 5.5M. Current cumulated incidence: $27/10^5$

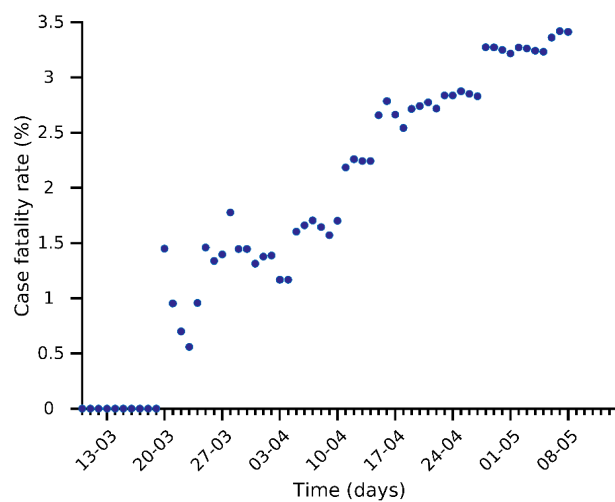
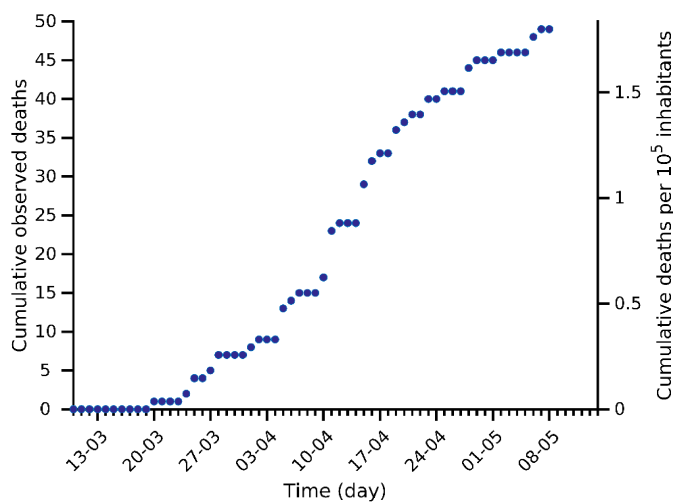
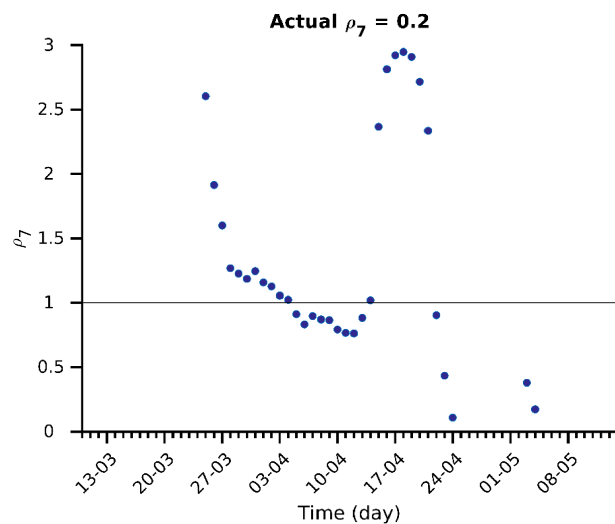
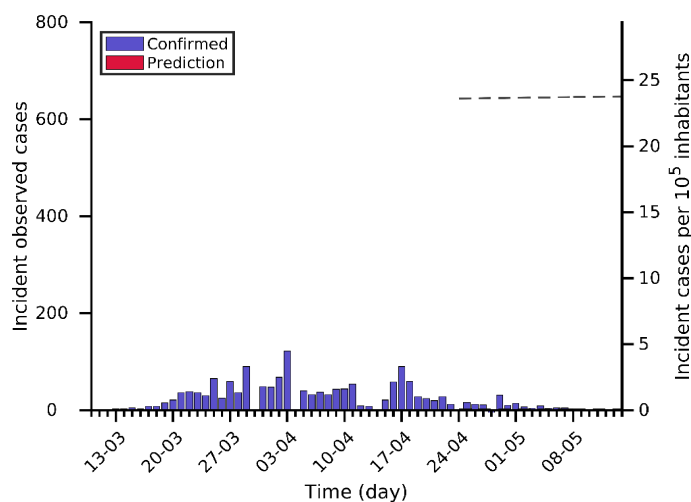
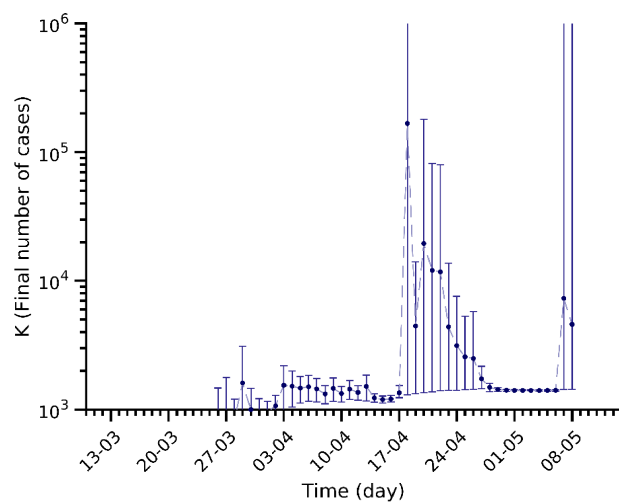
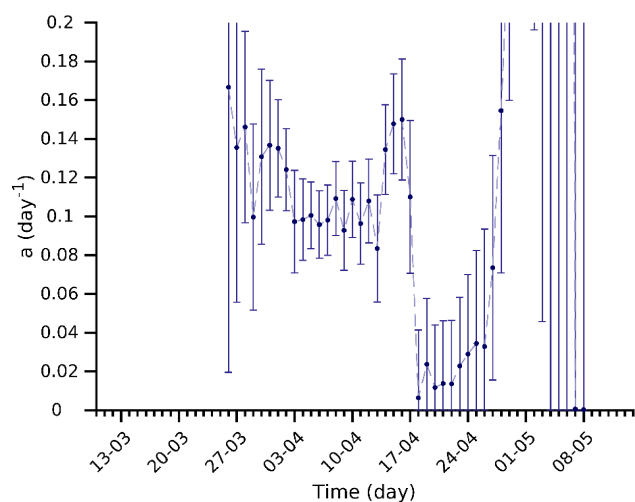
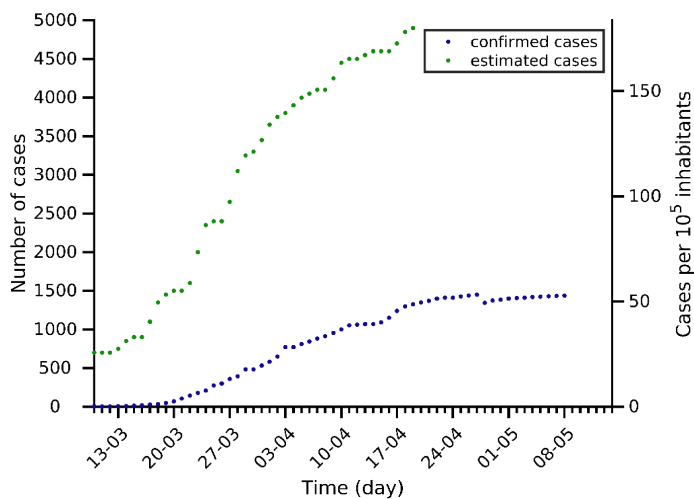
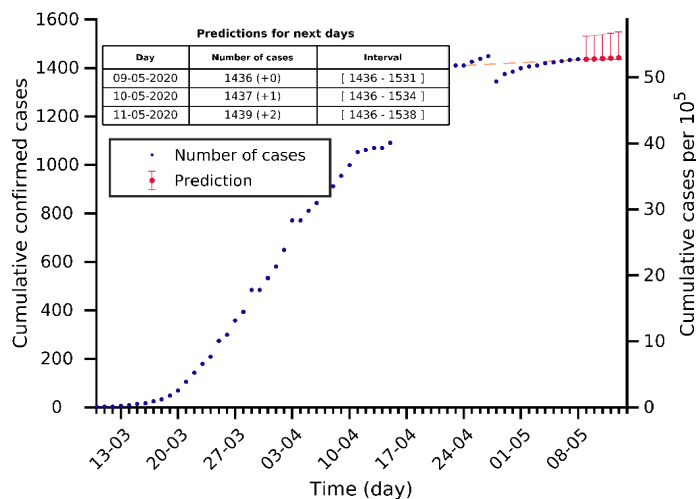




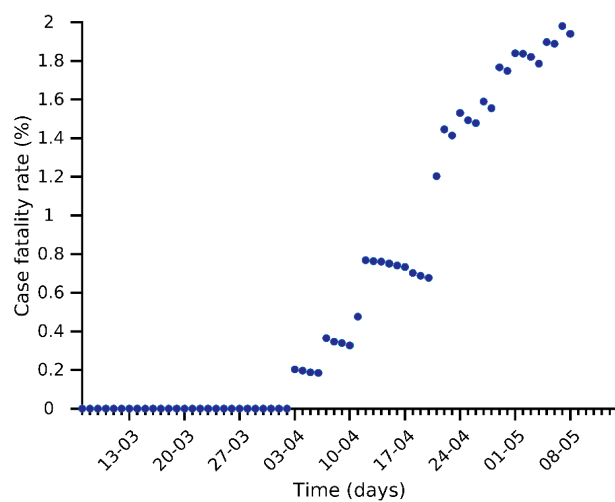
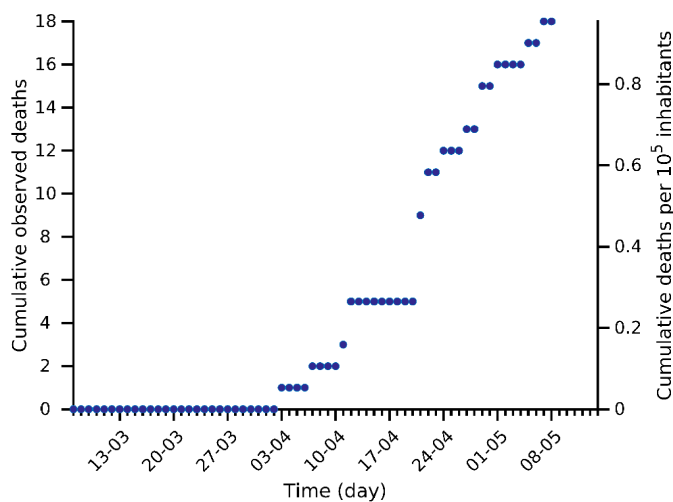
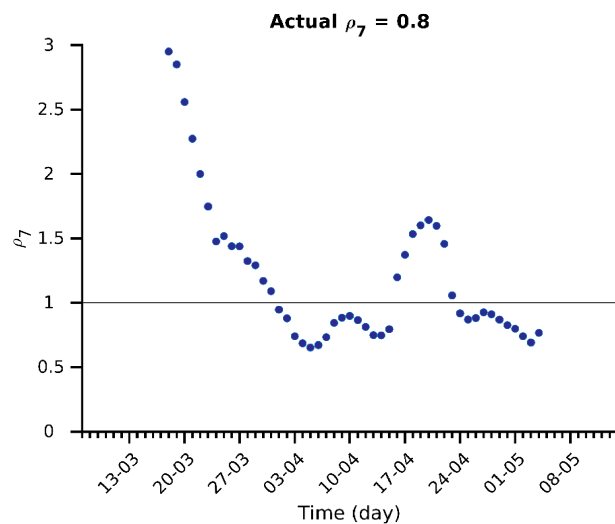
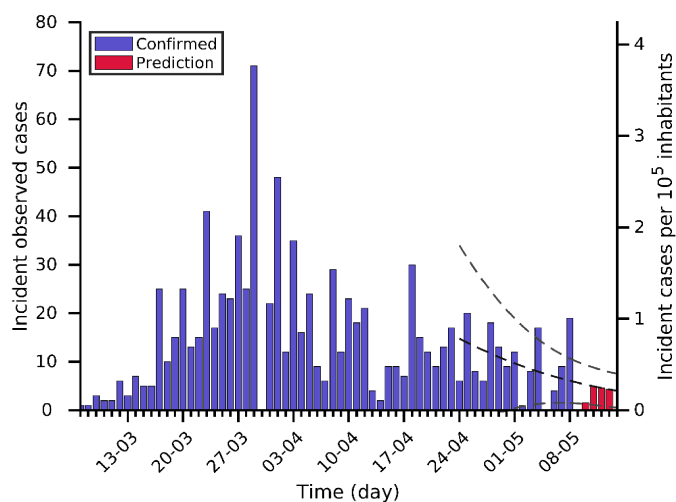
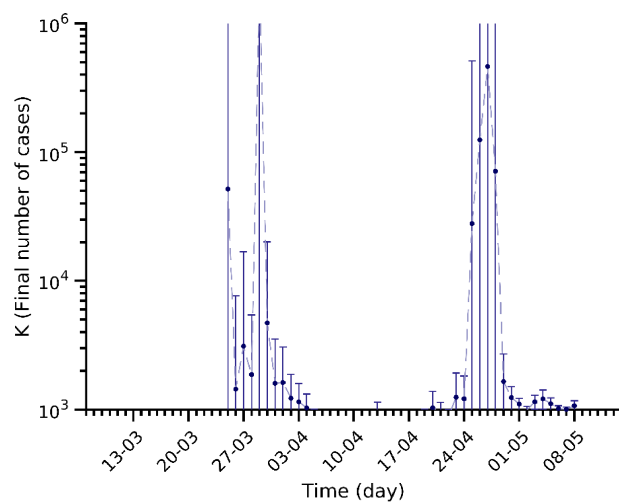
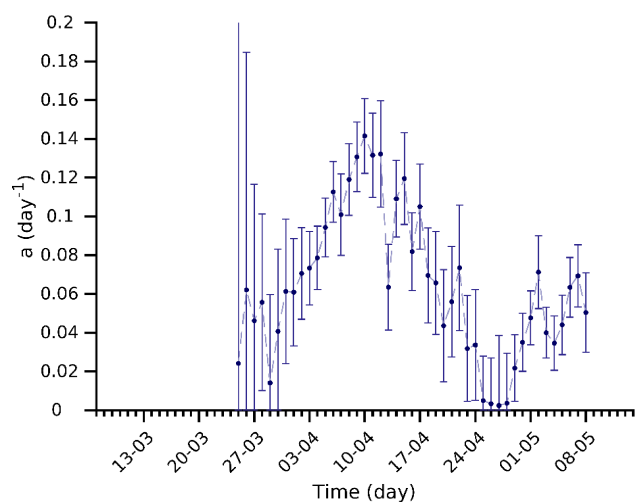
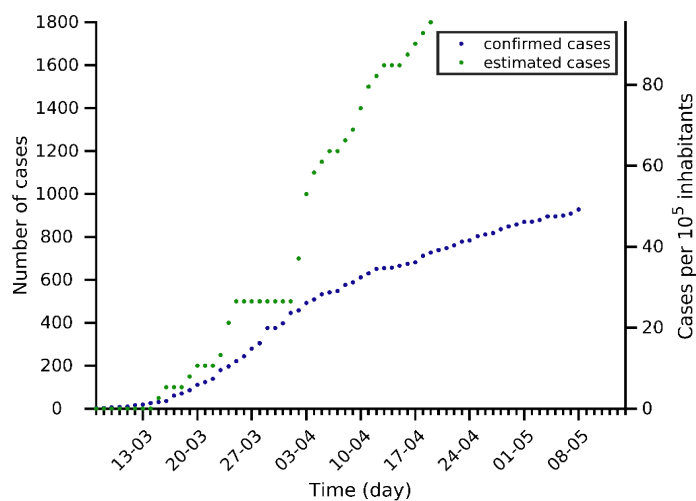
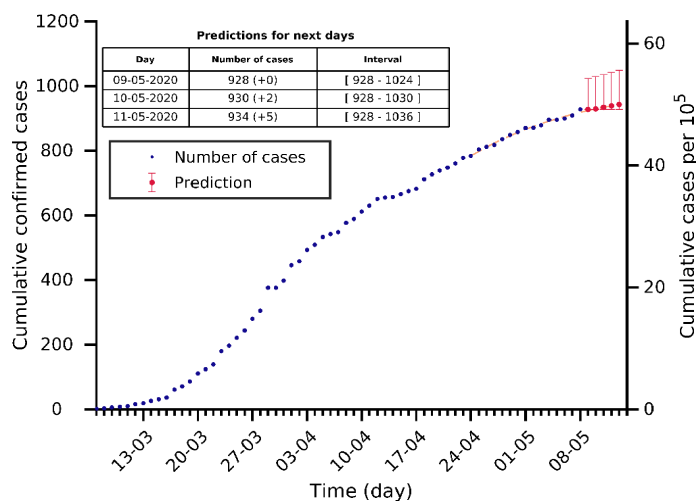
# Slovenia 08-05-2020. Population: 2.1M. Current cumulated incidence: 70/10<sup>5</sup>



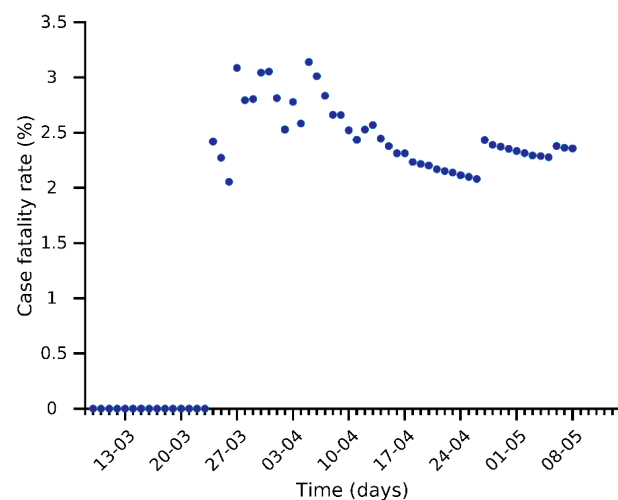
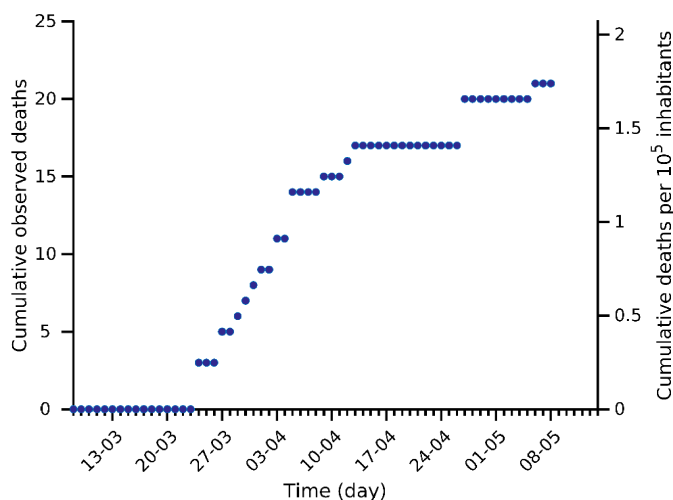
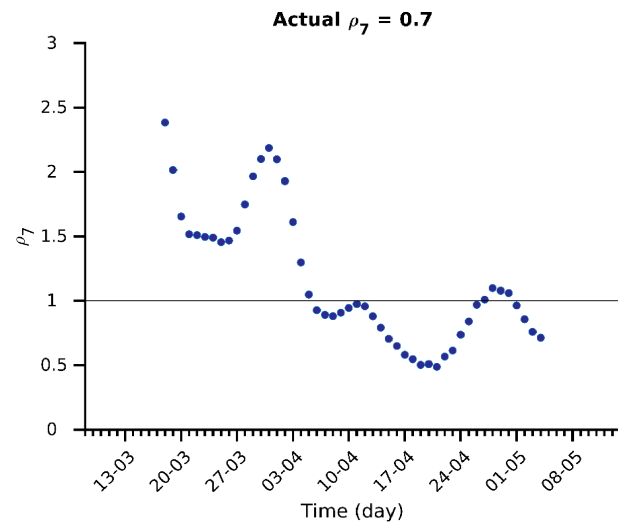
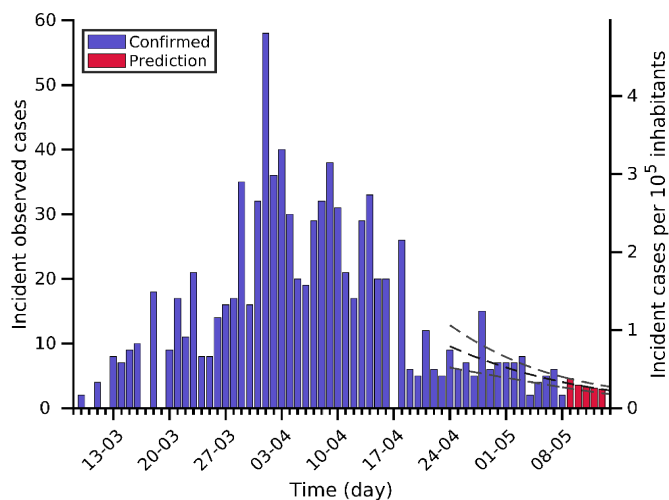
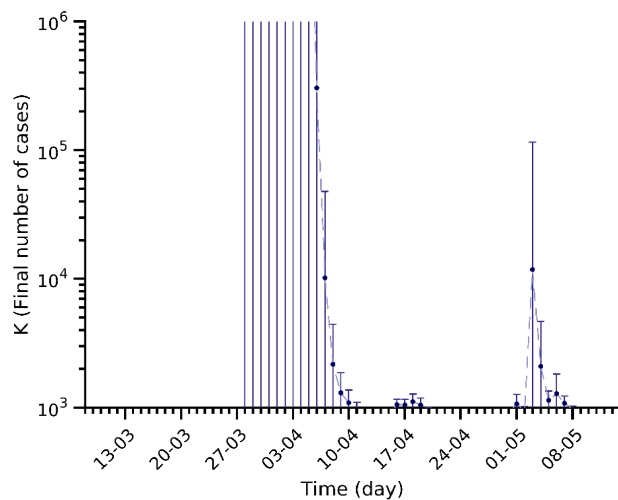
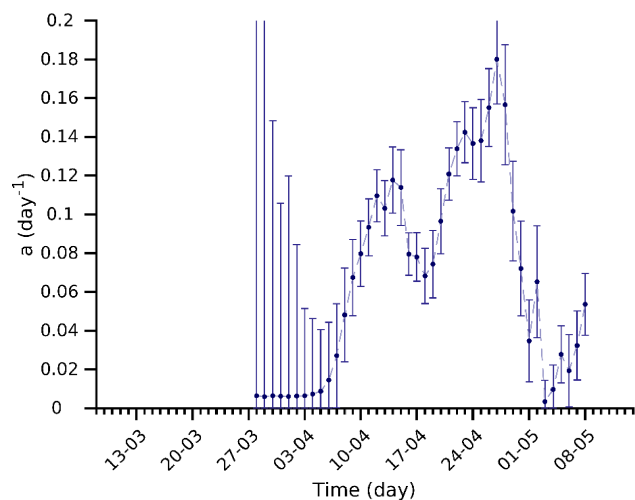
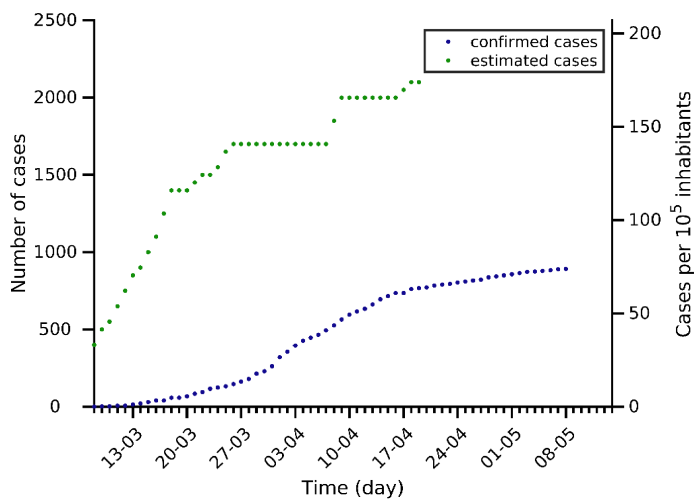
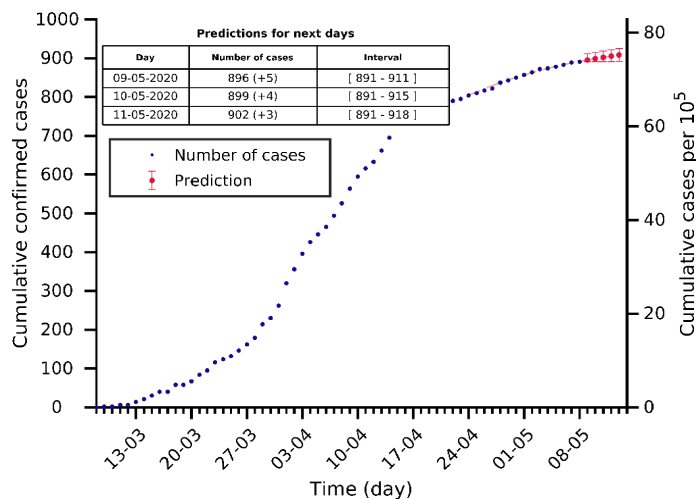
# Lithuania 08-05-2020. Population: 2.7M. Current cumulated incidence: 53/10<sup>5</sup>



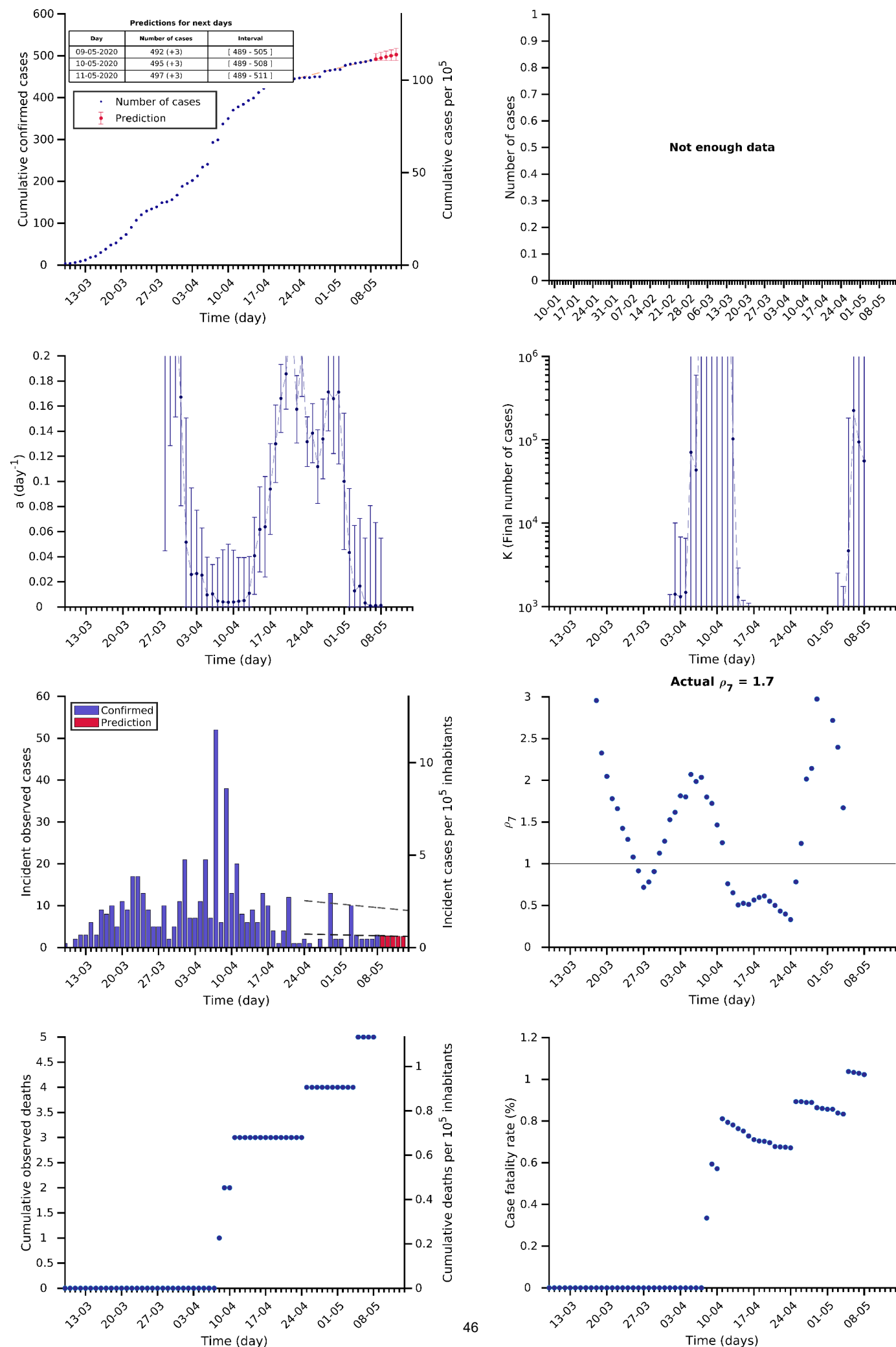
# Latvia 08-05-2020. Population: 1.9M. Current cumulated incidence: 49/10<sup>5</sup>



# Cyprus 08-05-2020. Population: 1.2M. Current cumulated incidence: 74/10<sup>5</sup>



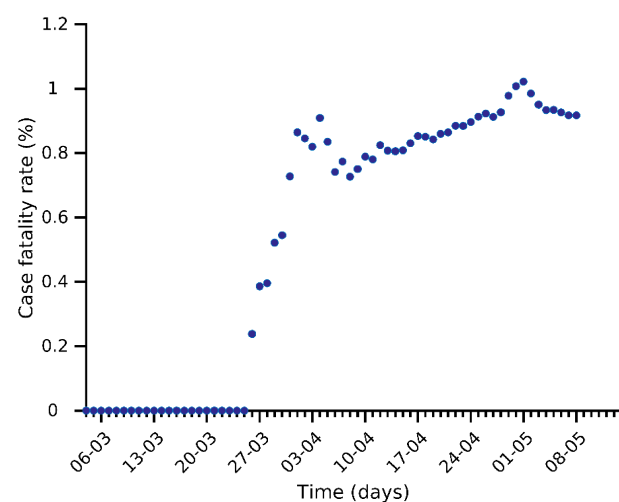
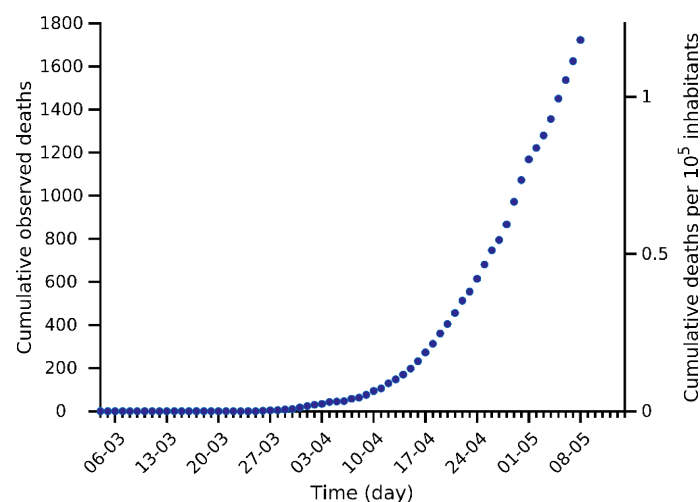
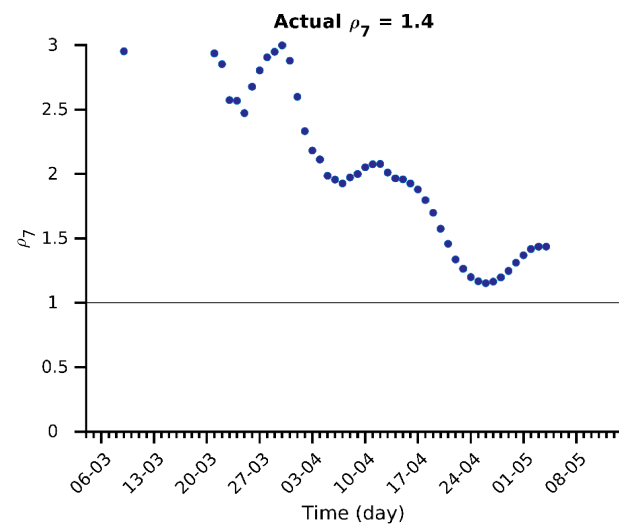
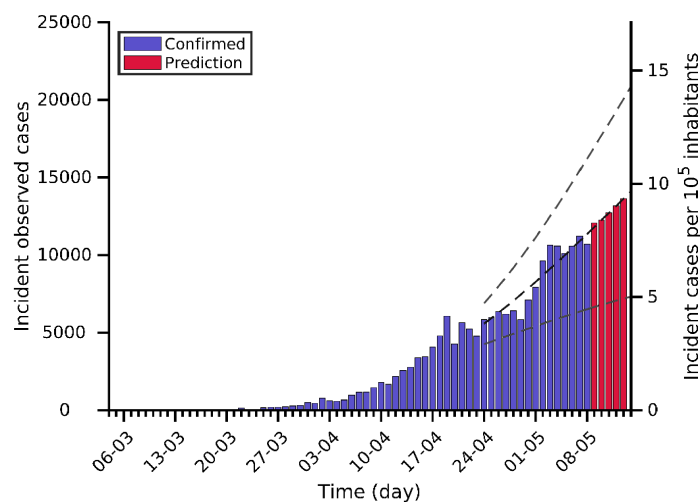
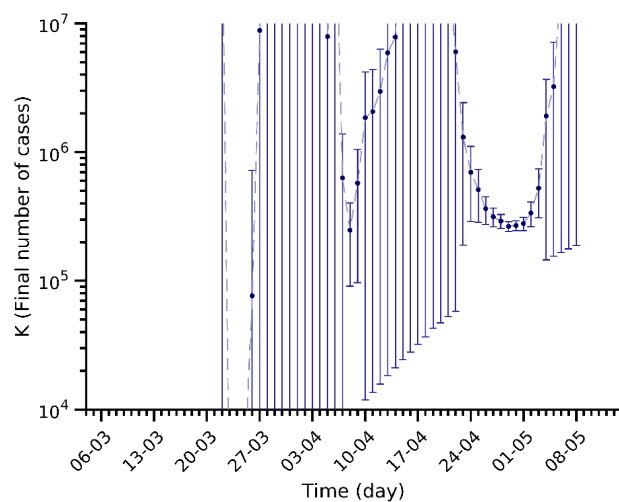
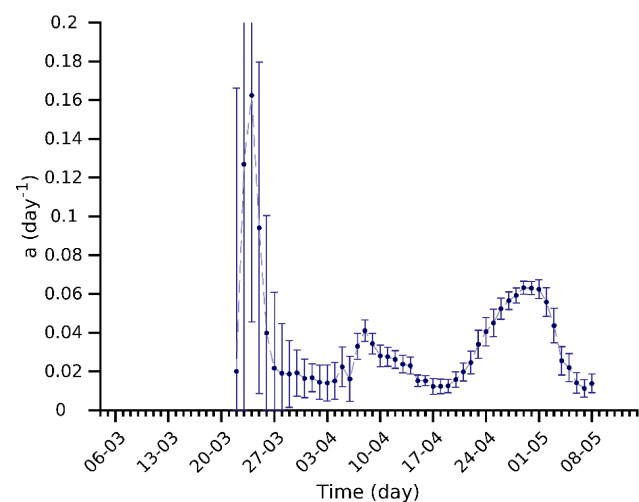
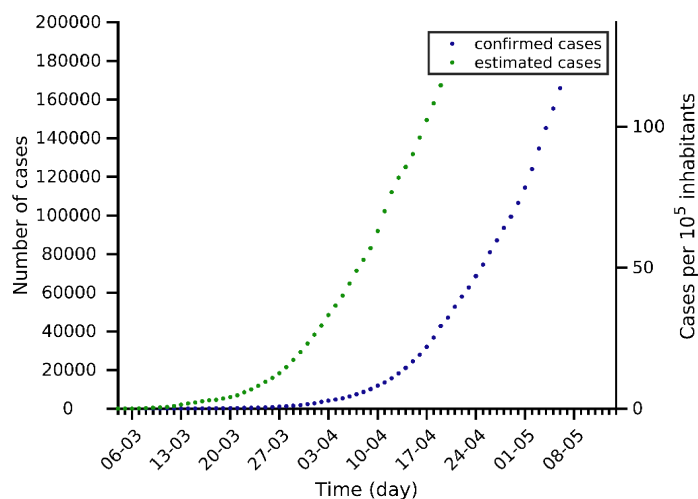
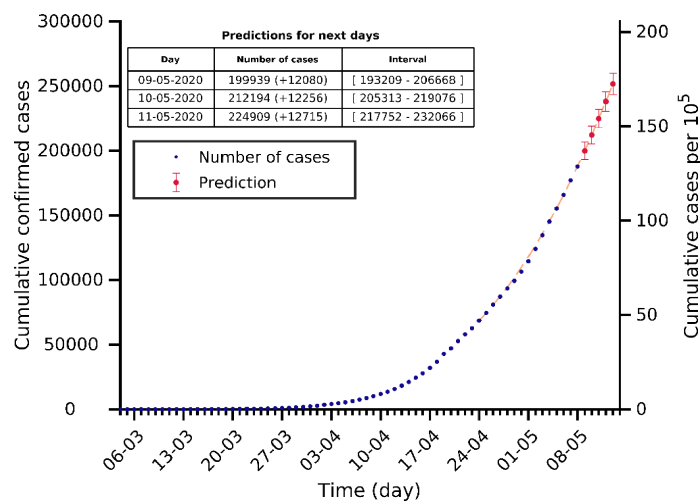
# Malta 08-05-2020. Population: 0.4M. Current cumulated incidence: 111/10<sup>5</sup>



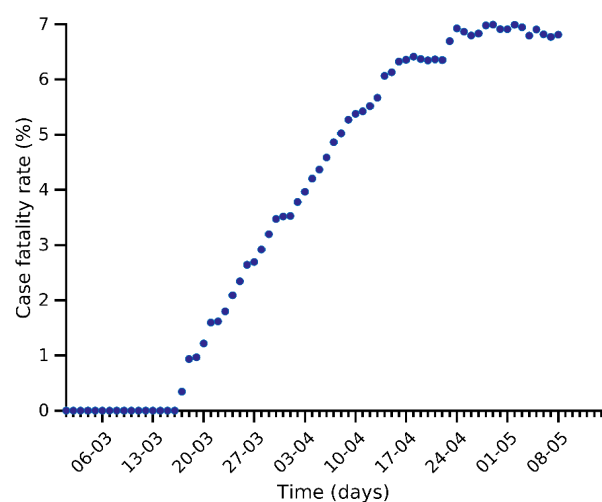
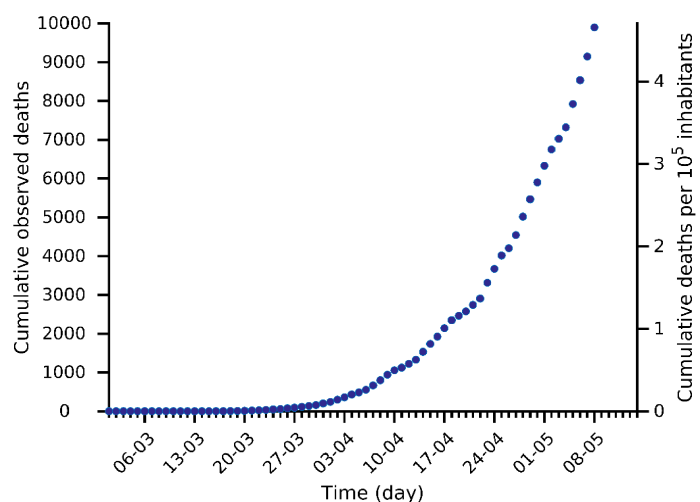
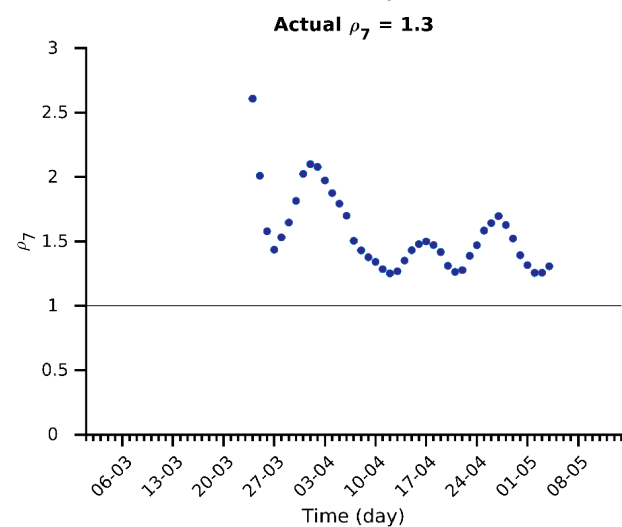
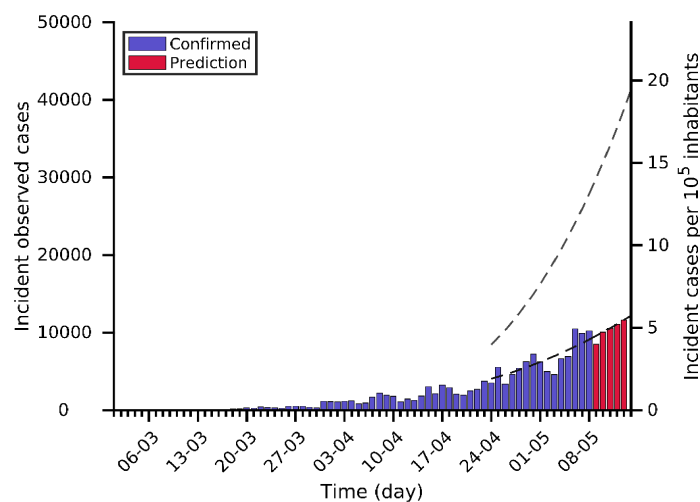
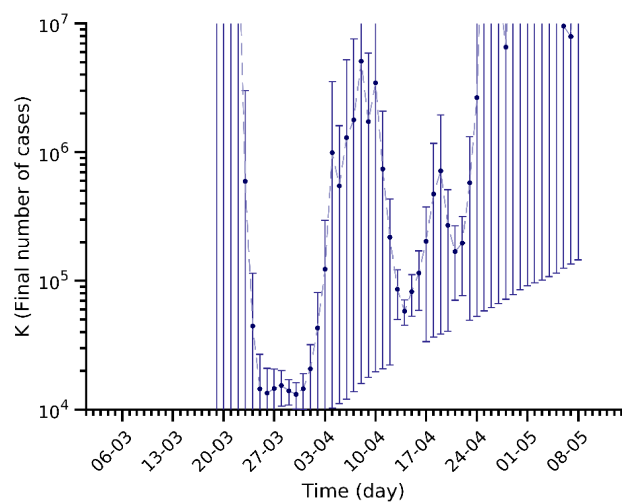
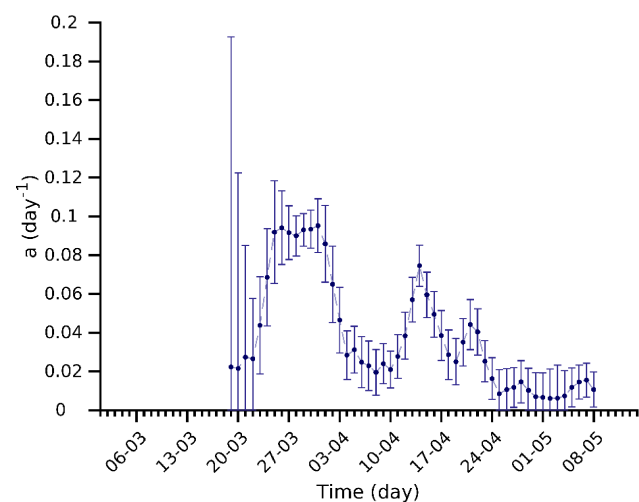
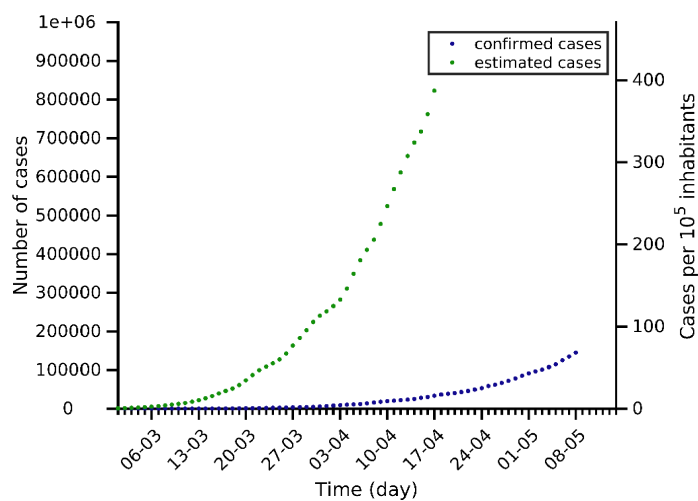
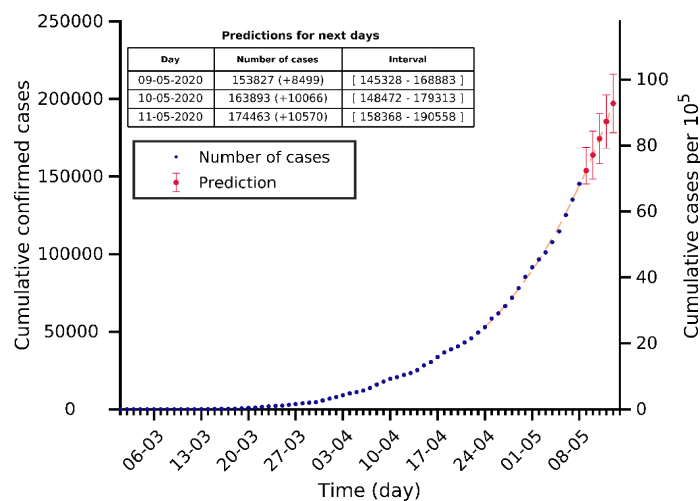
## **(2) Analysis and prediction of COVID-19 for other countries**

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

# Russia 08-05-2020. Population: 145.9M. Current cumulated incidence: 129/10<sup>5</sup>

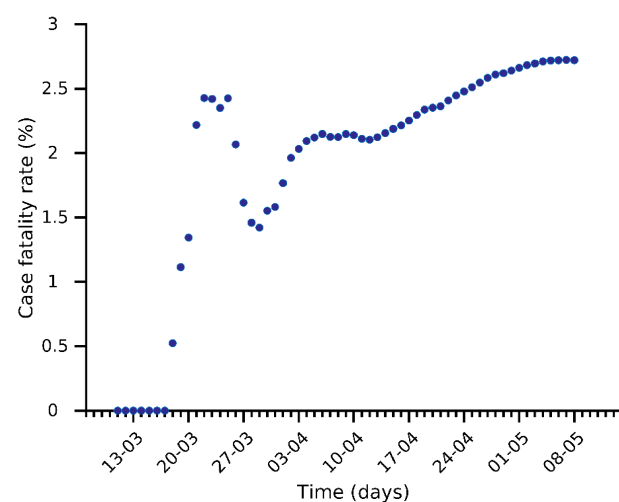
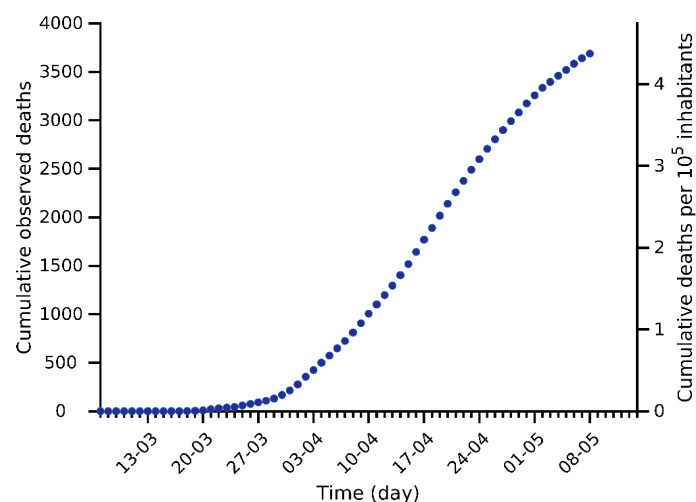
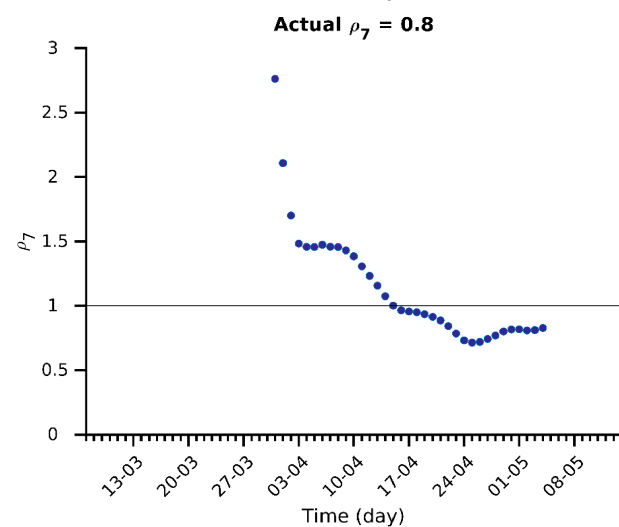
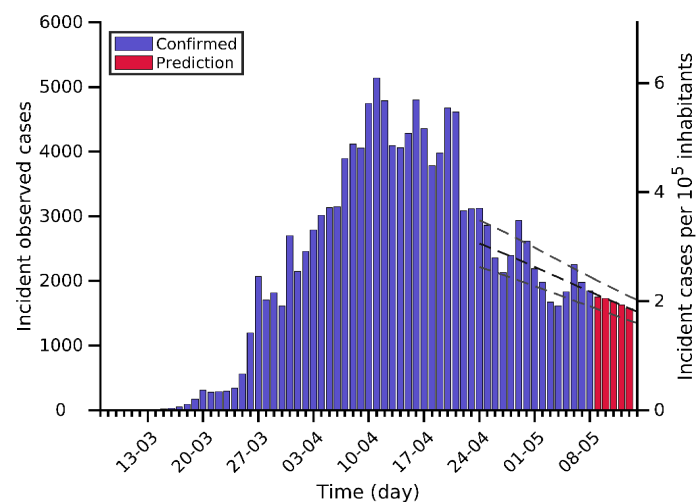
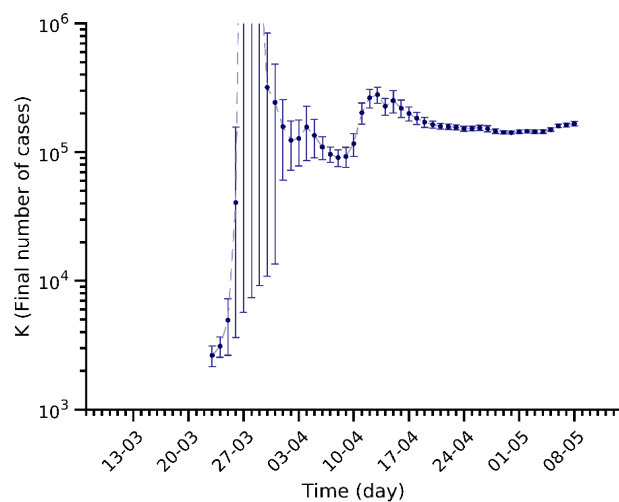
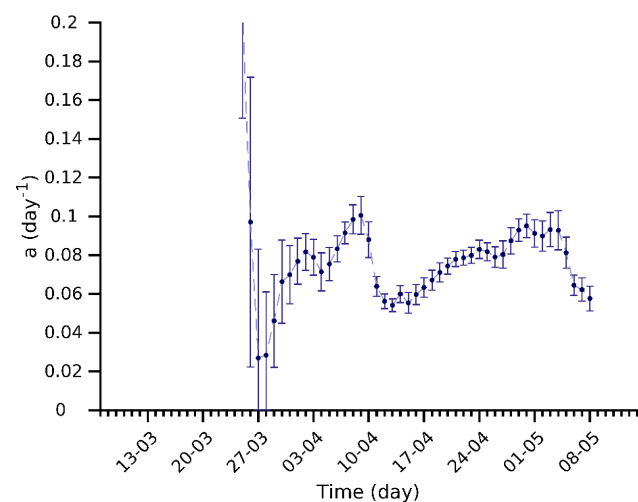
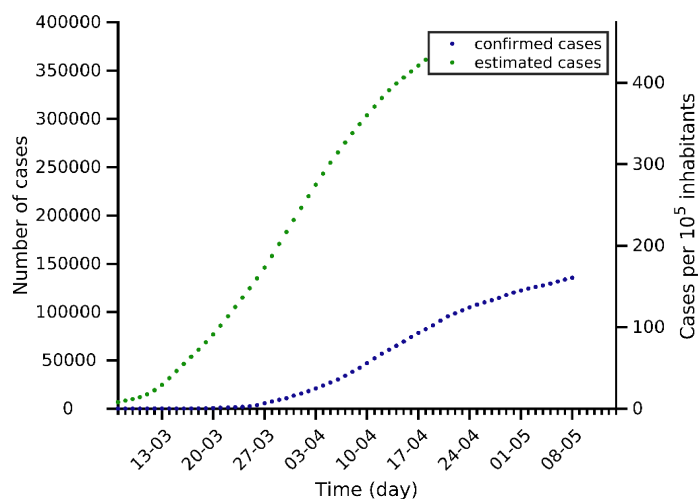
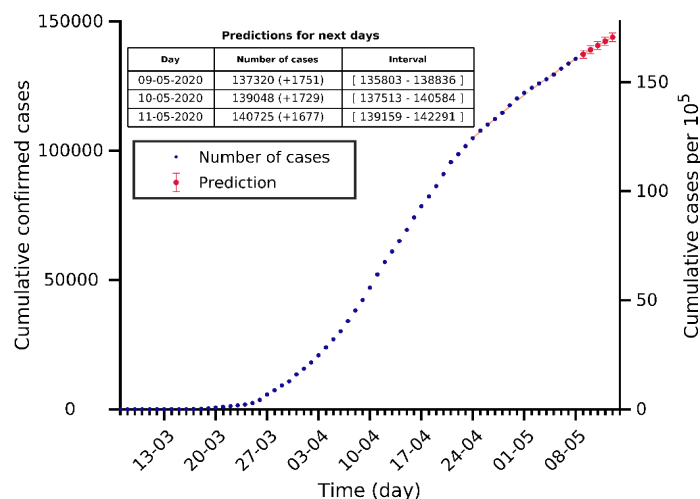


# Brazil 08-05-2020. Population: 212.6M. Current cumulated incidence: 68/10<sup>5</sup>

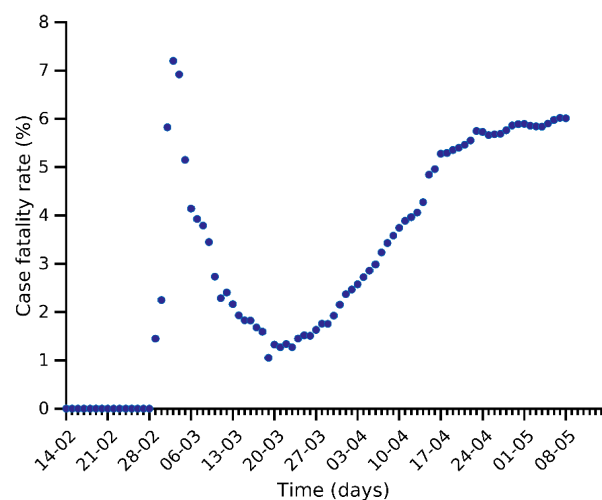
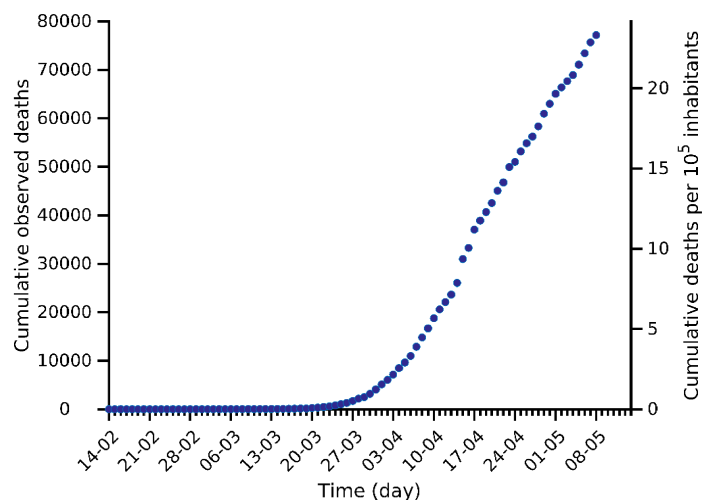
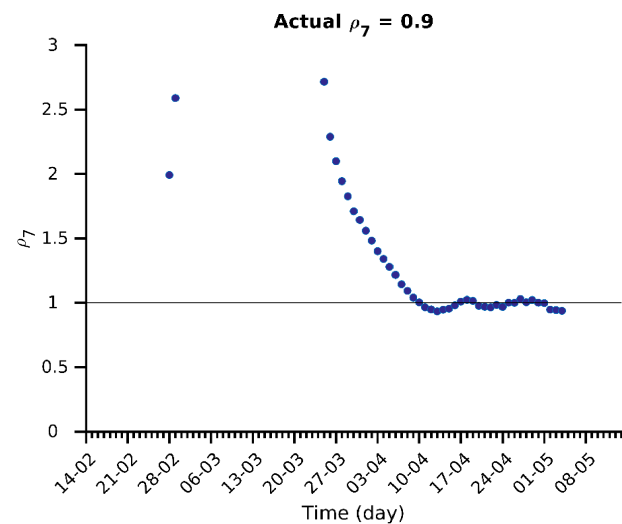
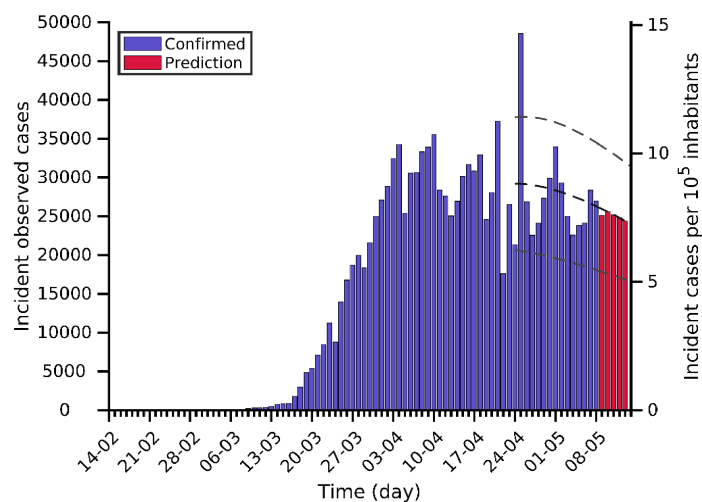
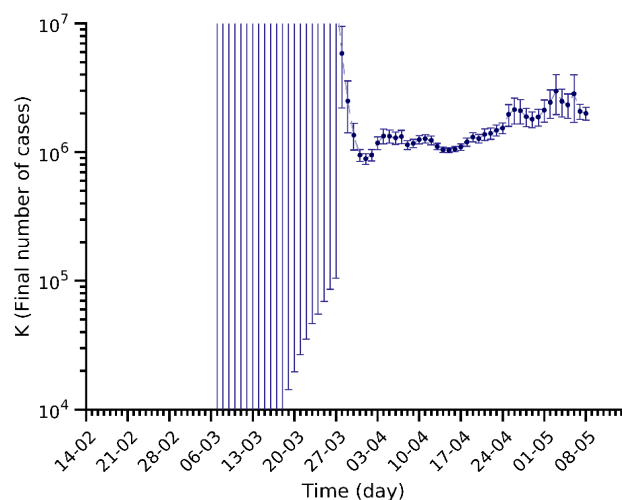
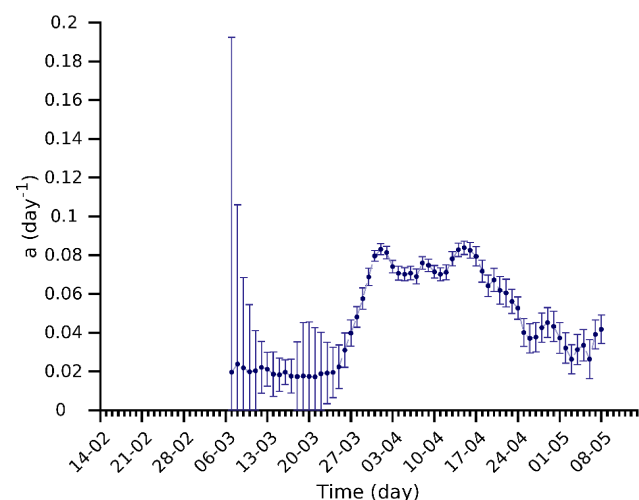
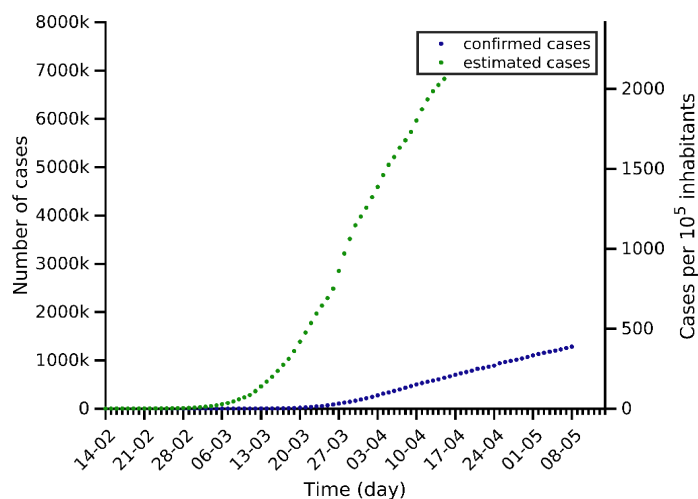
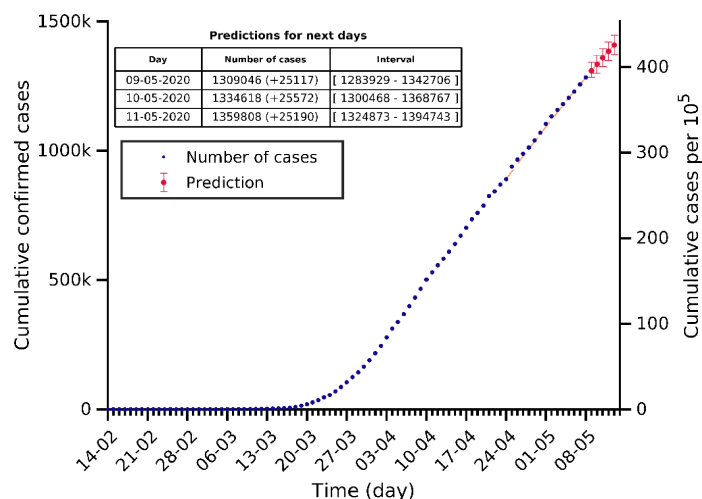




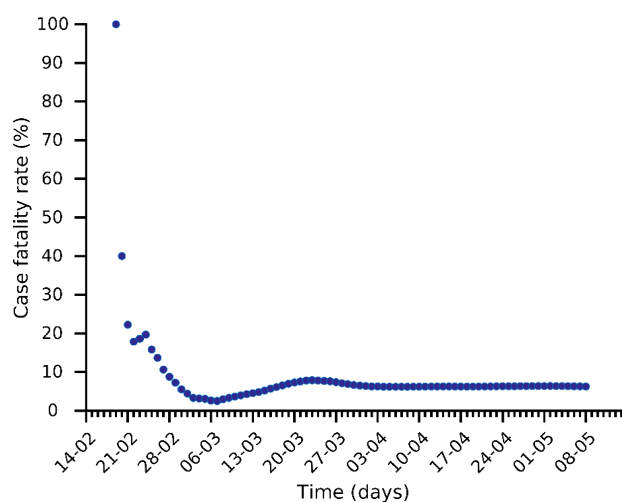
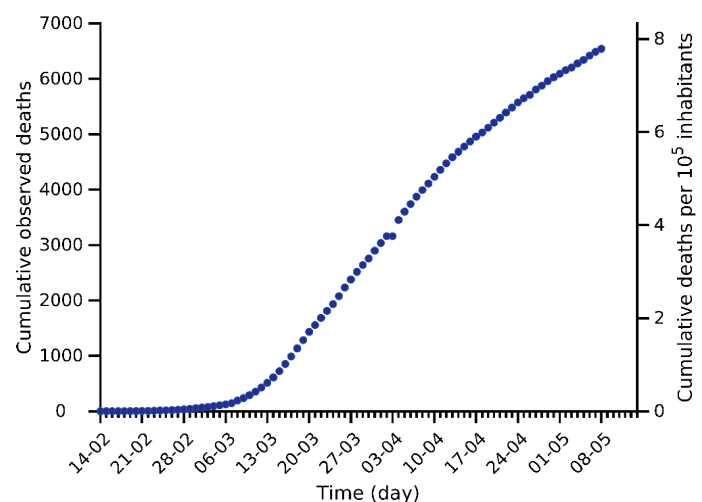
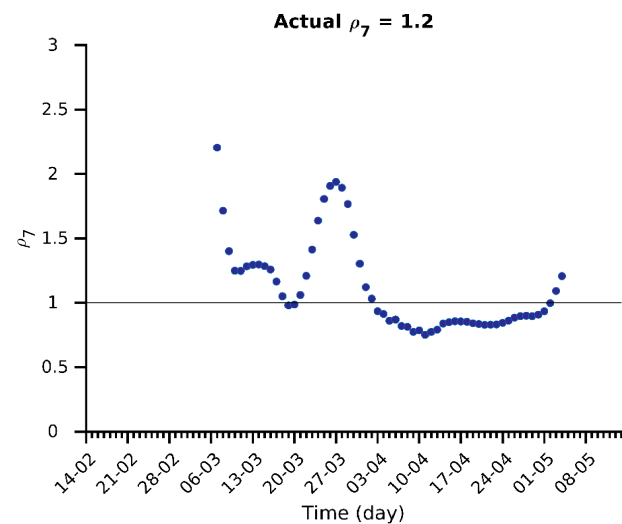
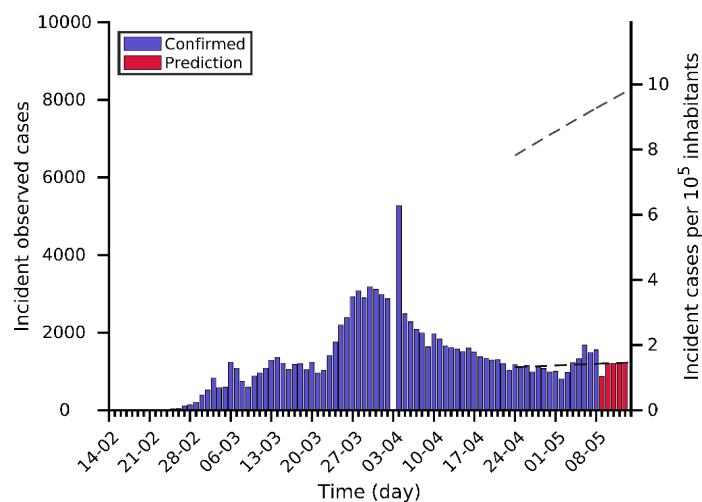
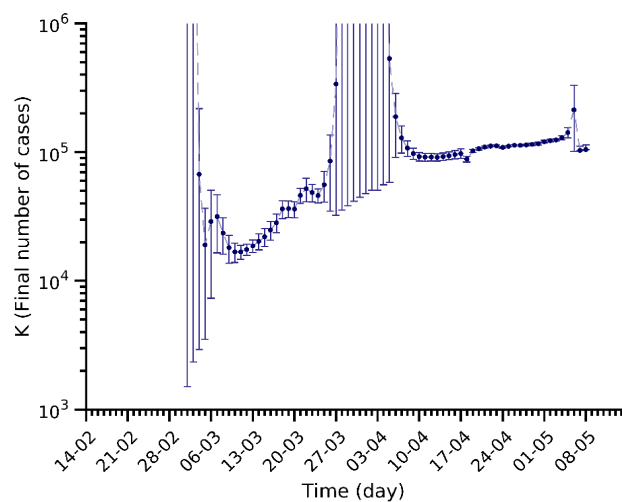
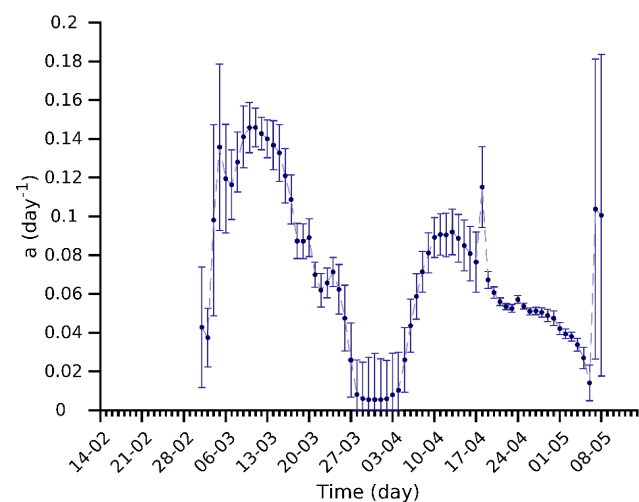
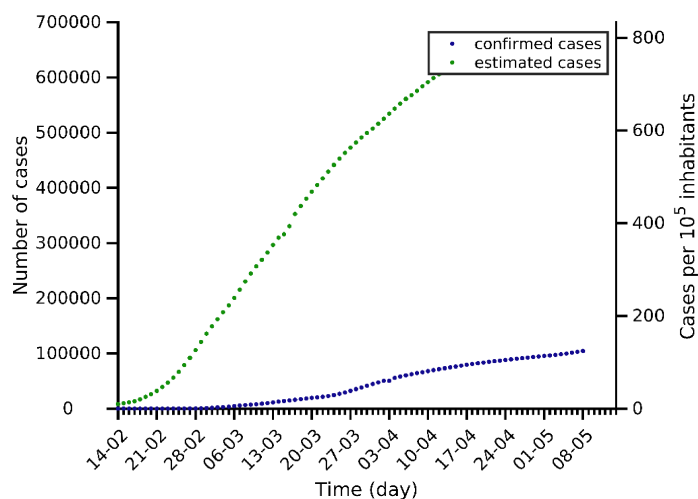
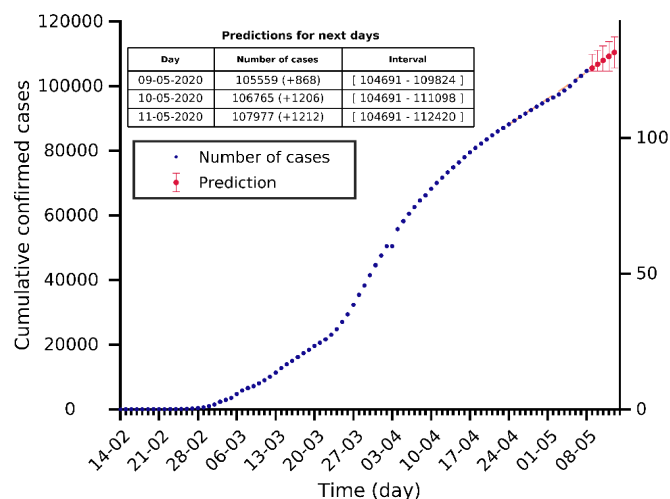
# Turkey 08-05-2020. Population: 84.3M. Current cumulated incidence: 161/10<sup>5</sup>



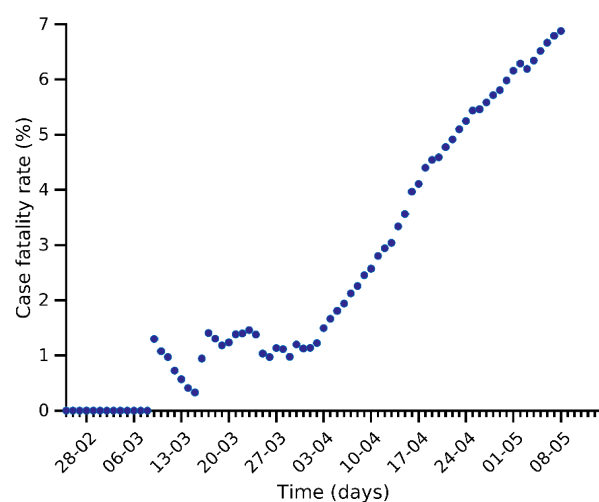
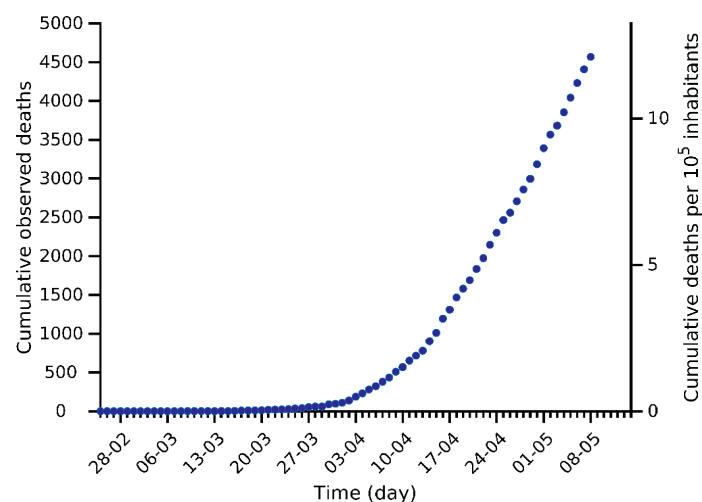
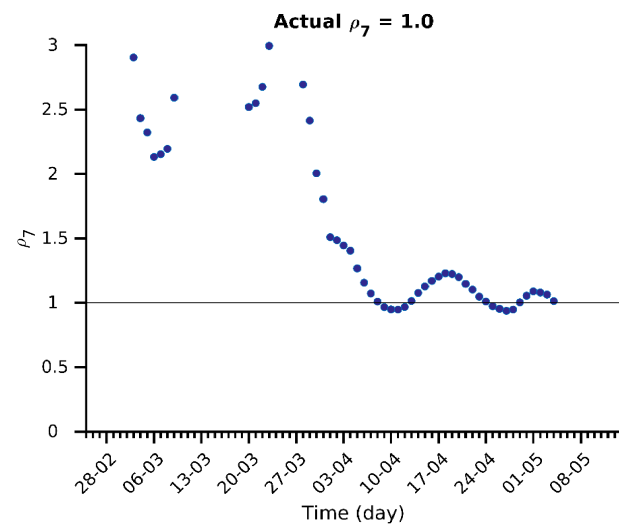
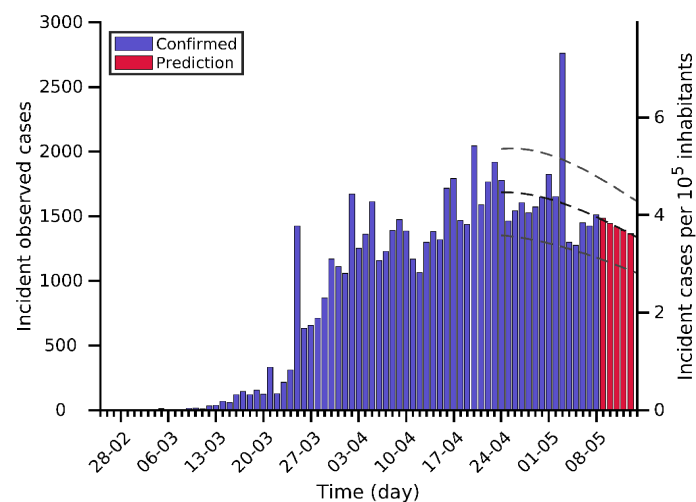
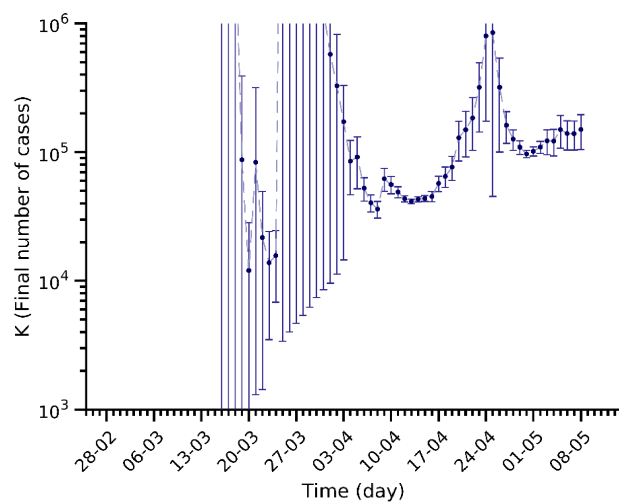
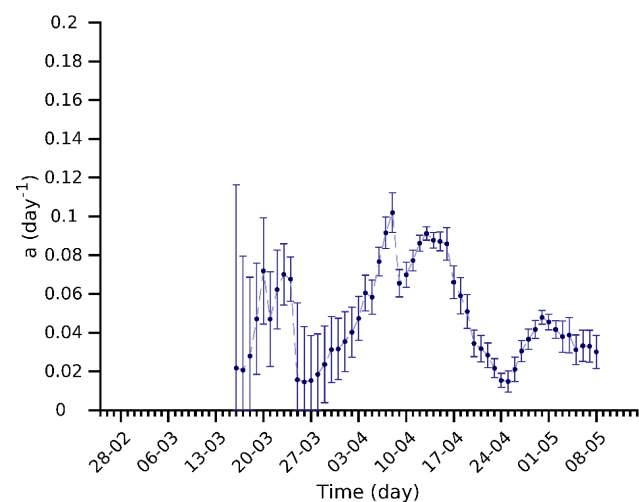
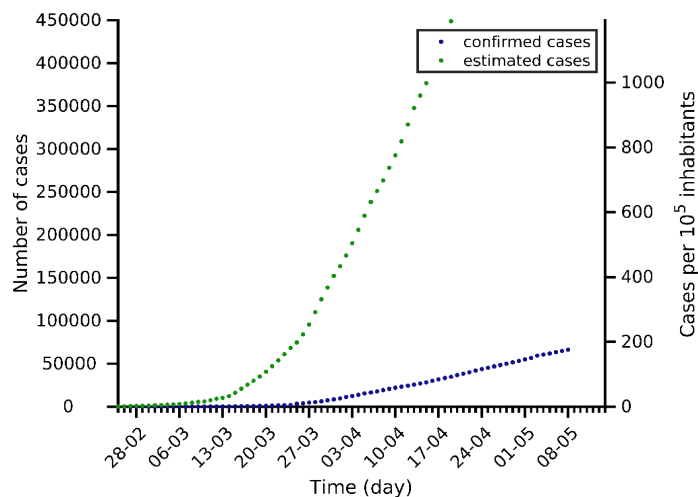
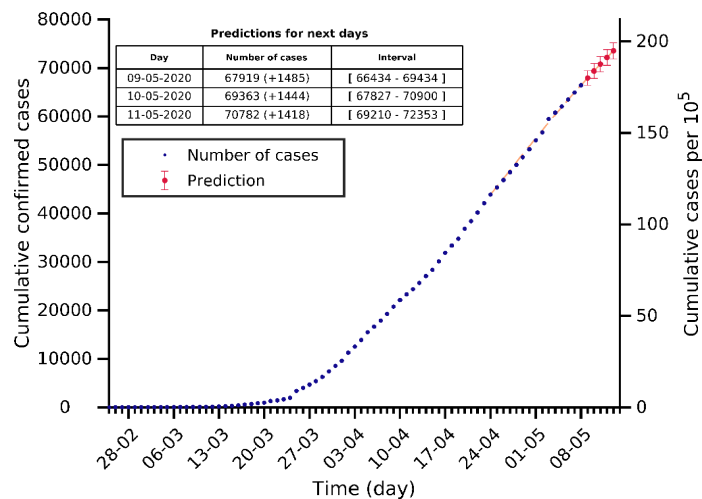
# USA 08-05-2020. Population: 331.0M. Current cumulated incidence: 388/10<sup>5</sup>



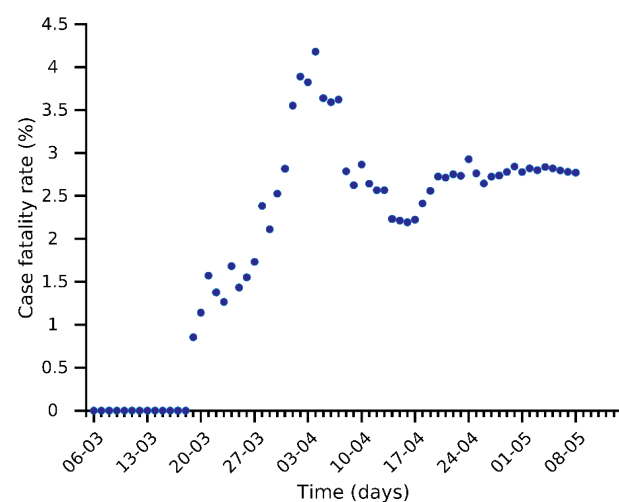
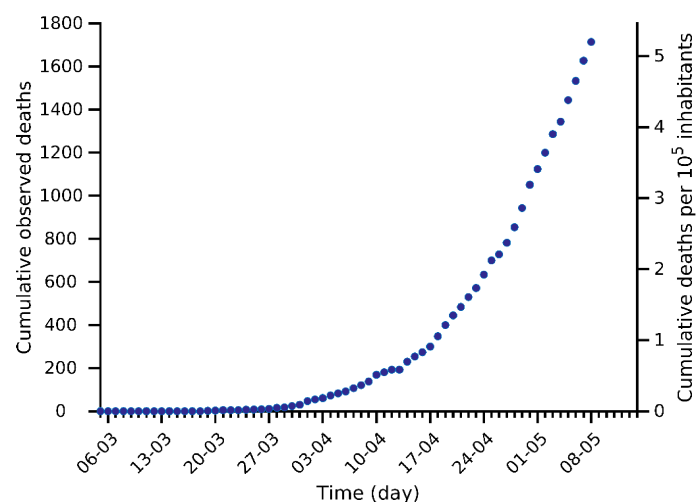
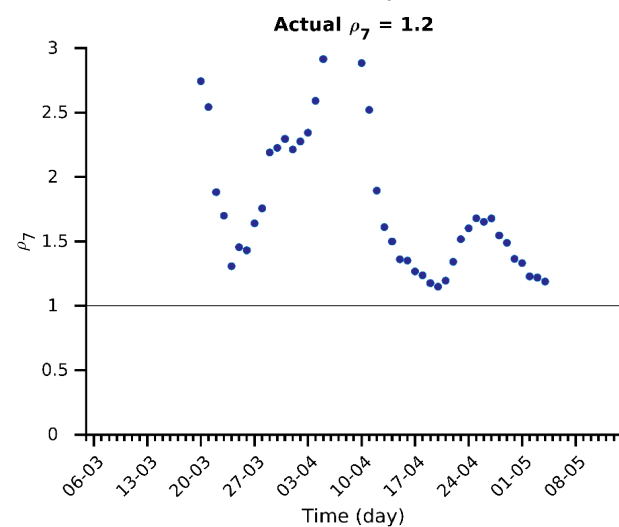
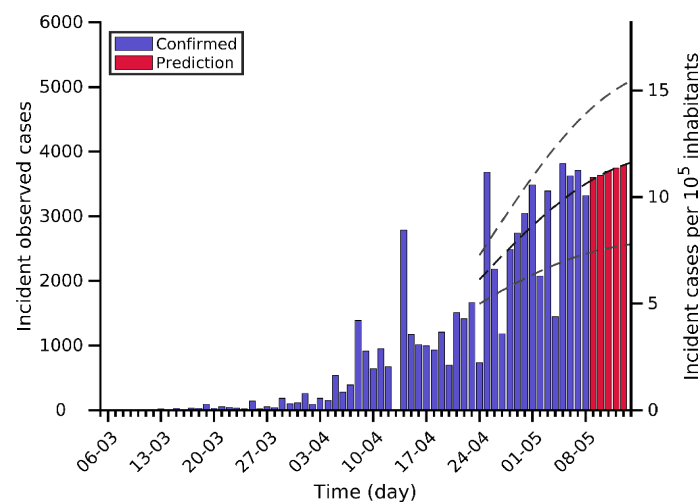
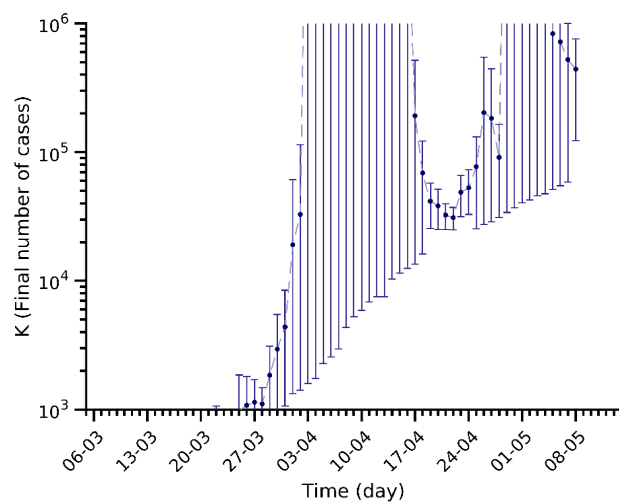
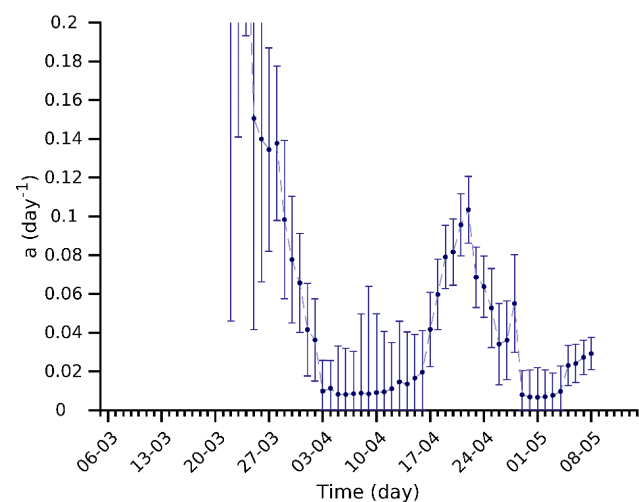
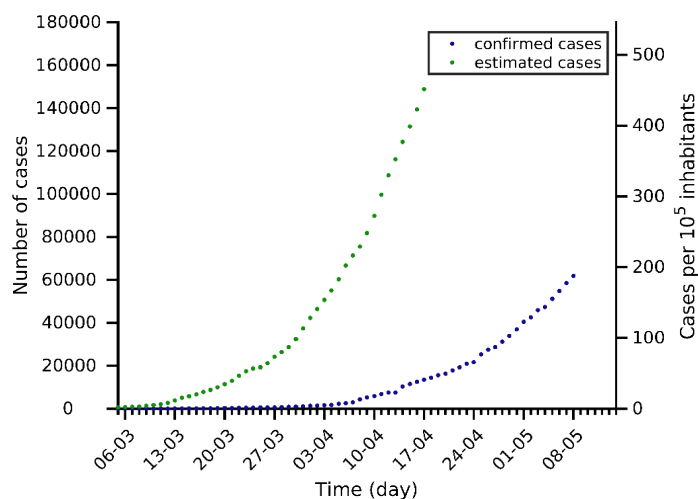
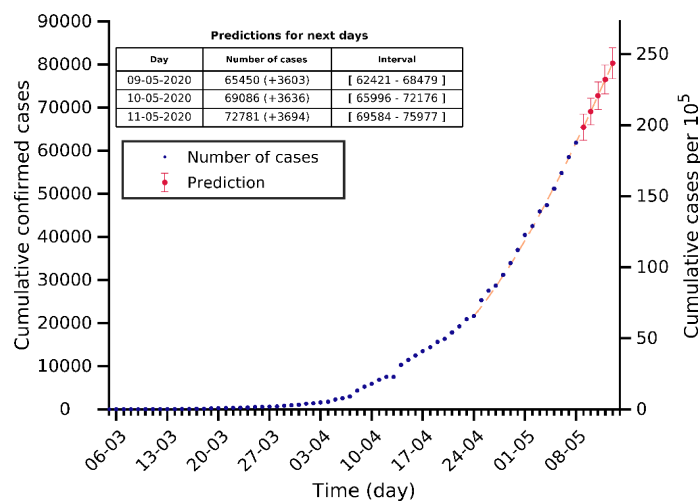
# Iran 08-05-2020. Population: 84.0M. Current cumulated incidence: 125/10<sup>5</sup>



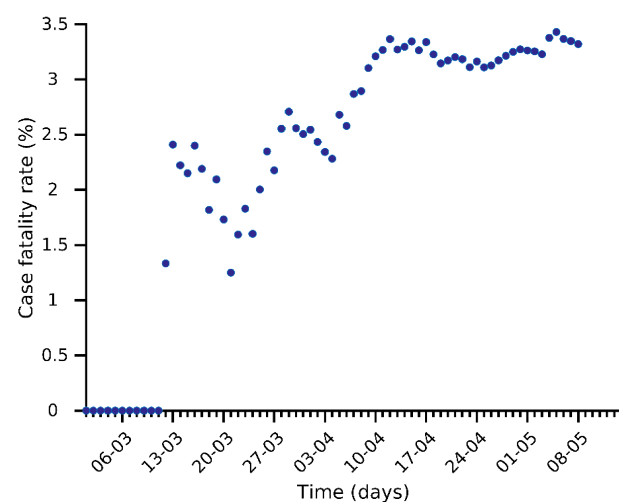
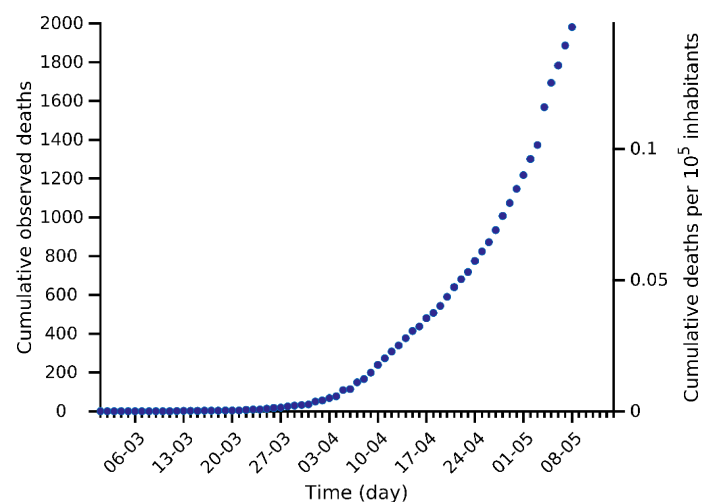
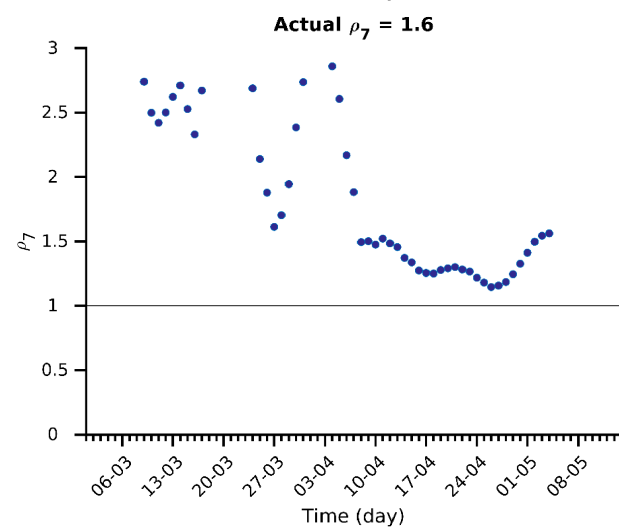
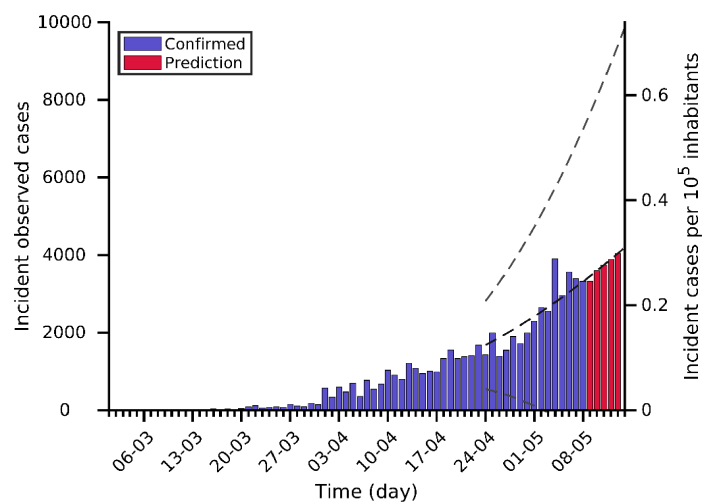
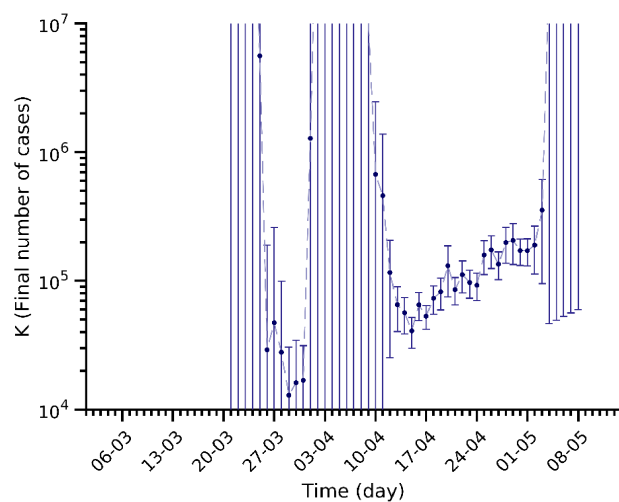
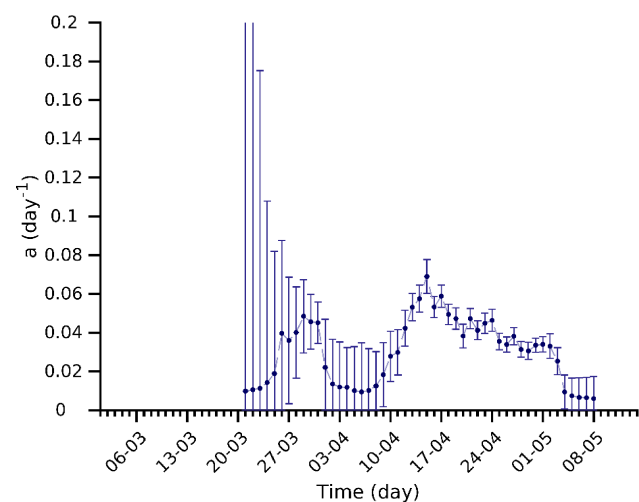
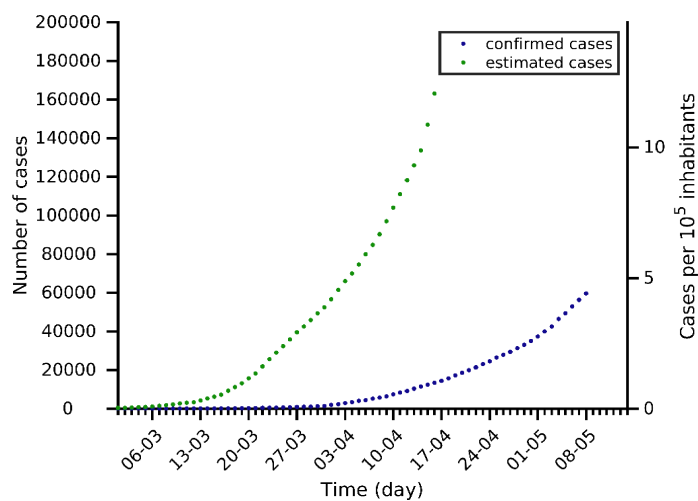
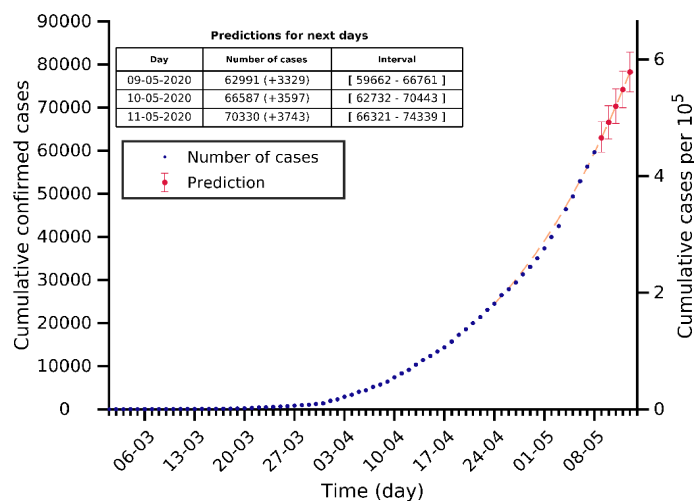
# Canada 08-05-2020. Population: 37.7M. Current cumulated incidence: 176/10<sup>5</sup>



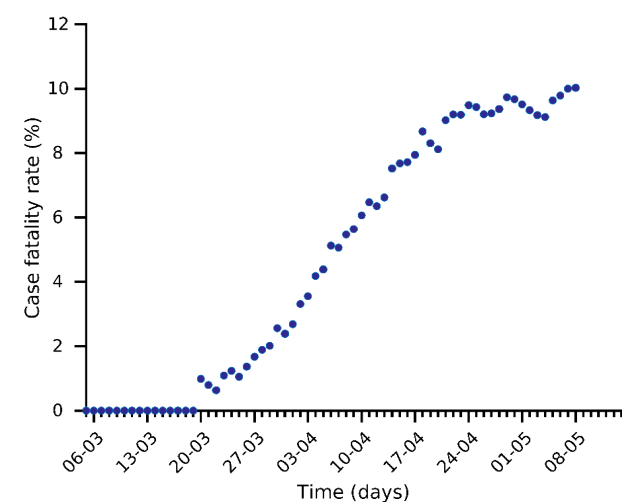
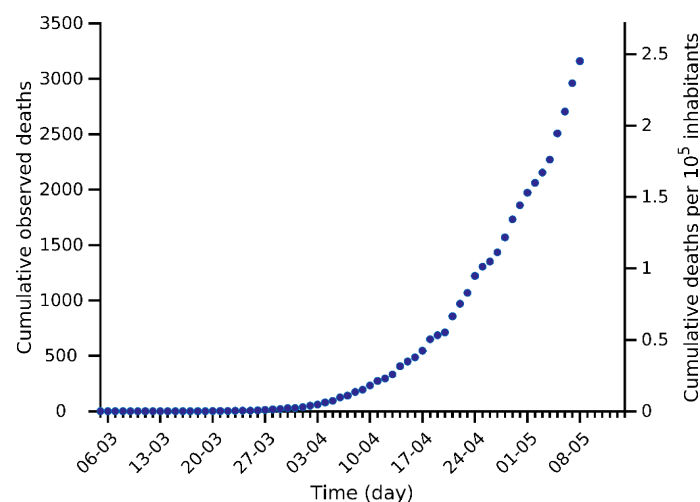
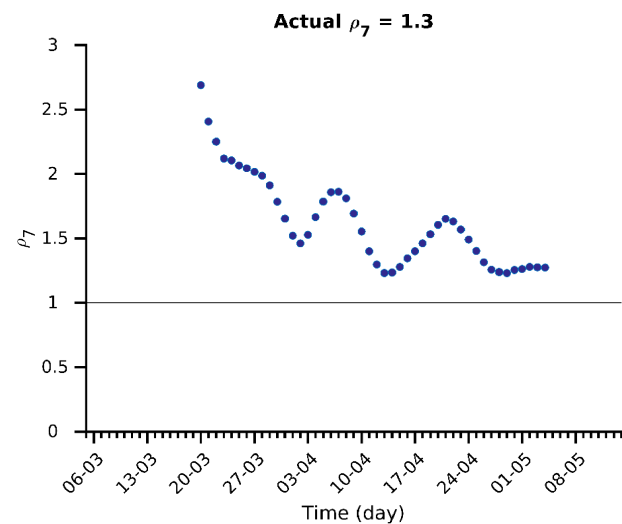
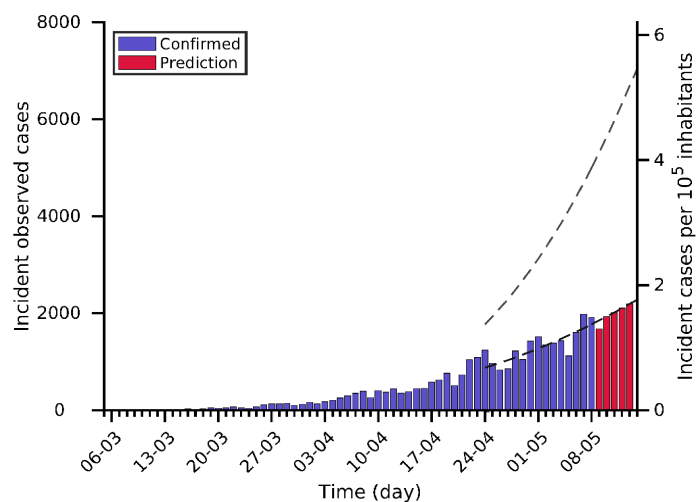
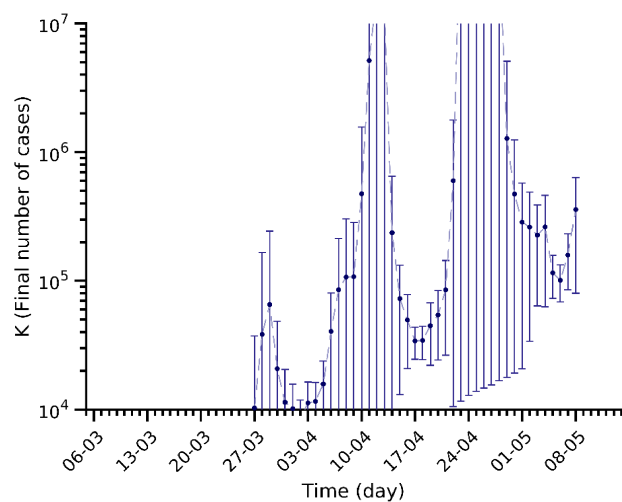
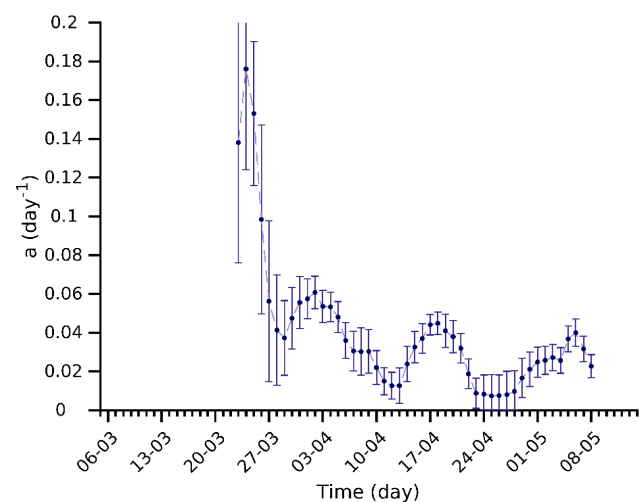
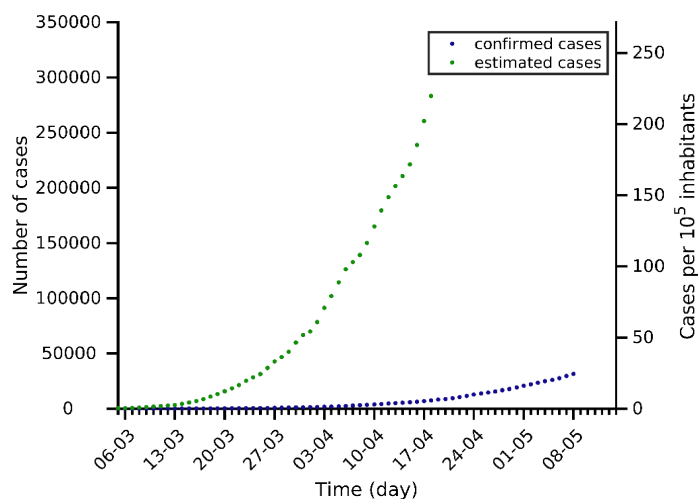
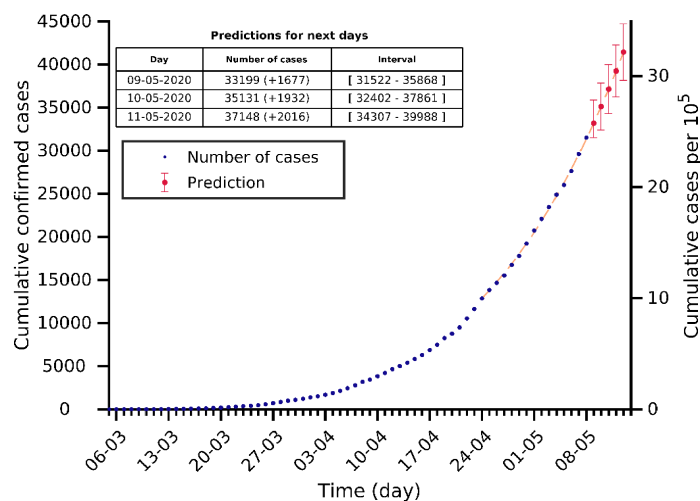
# Peru 08-05-2020. Population: 33.0M. Current cumulated incidence: 188/10<sup>5</sup>



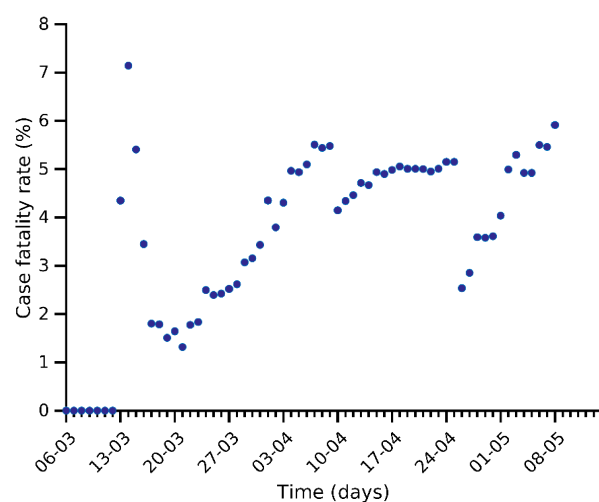
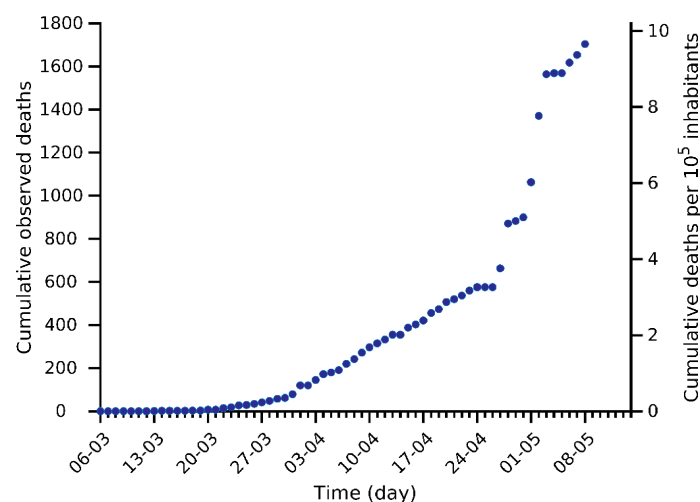
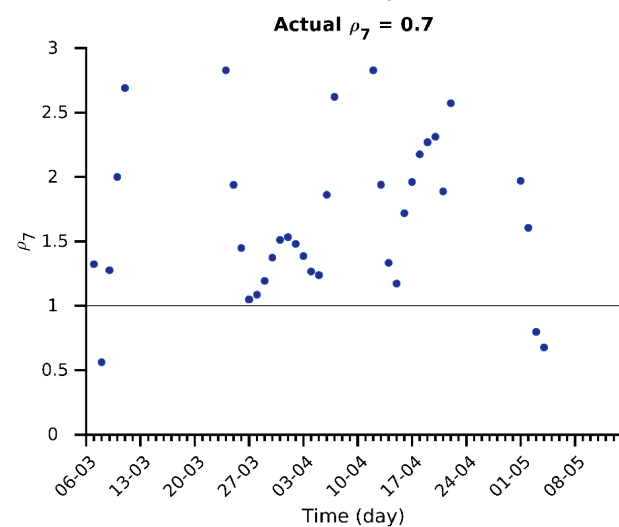
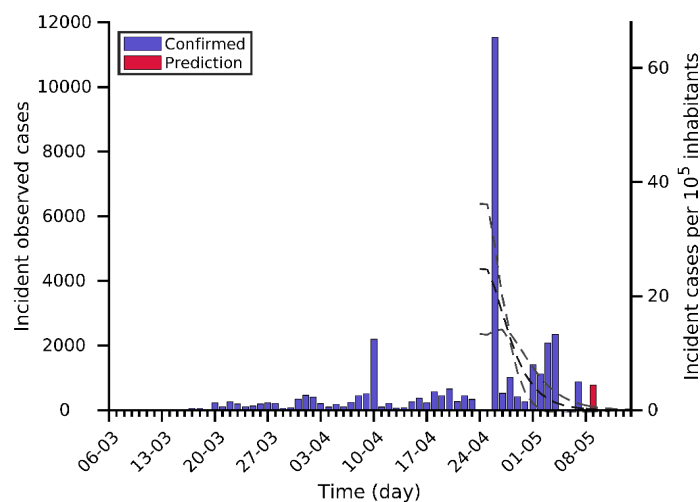
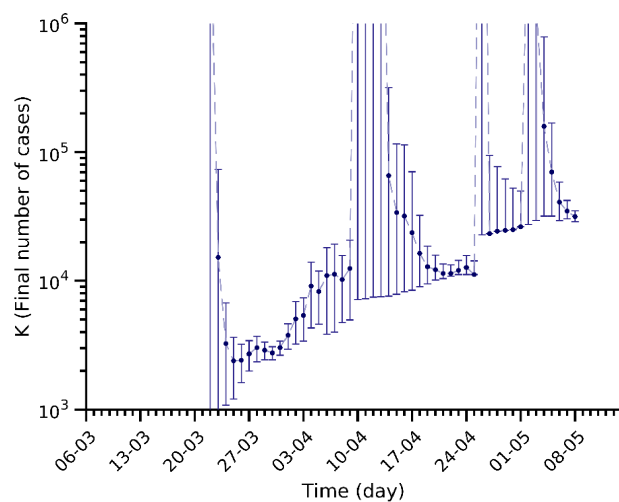
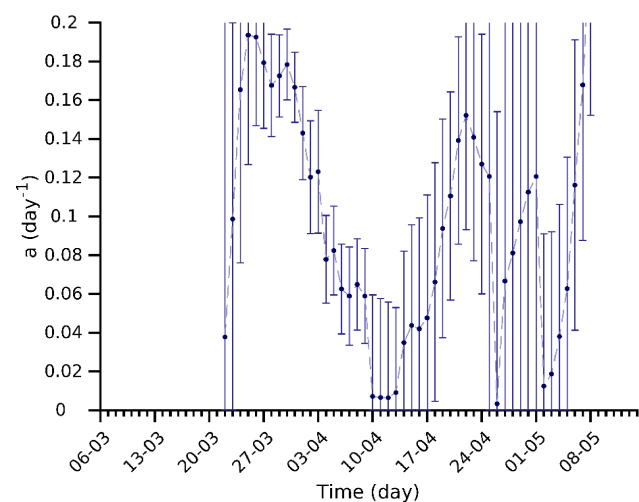
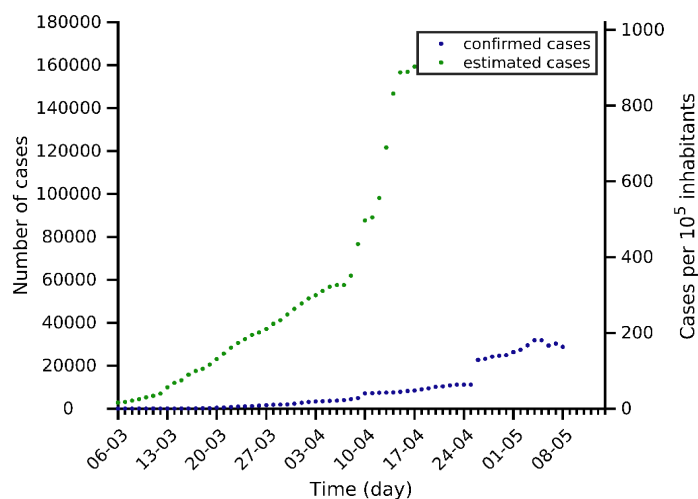
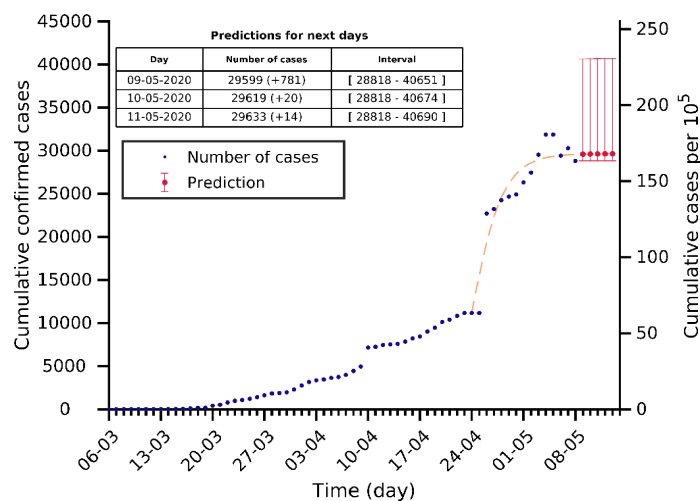
# India 08-05-2020. Population: 1353.0M. Current cumulated incidence: 4/10<sup>5</sup>



# Mexico 08-05-2020. Population: 128.9M. Current cumulated incidence: 24/10<sup>5</sup>

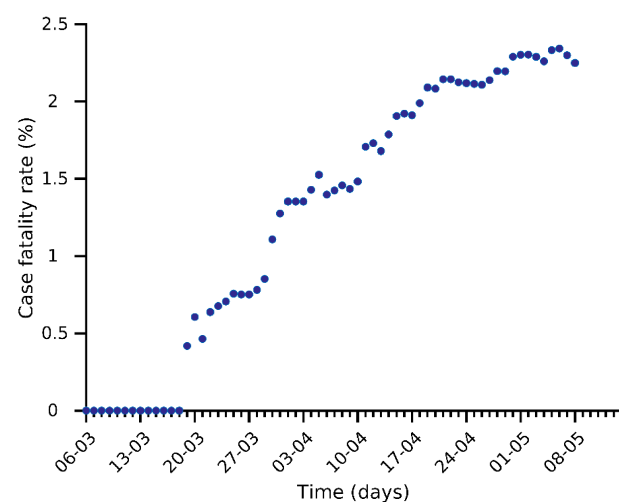
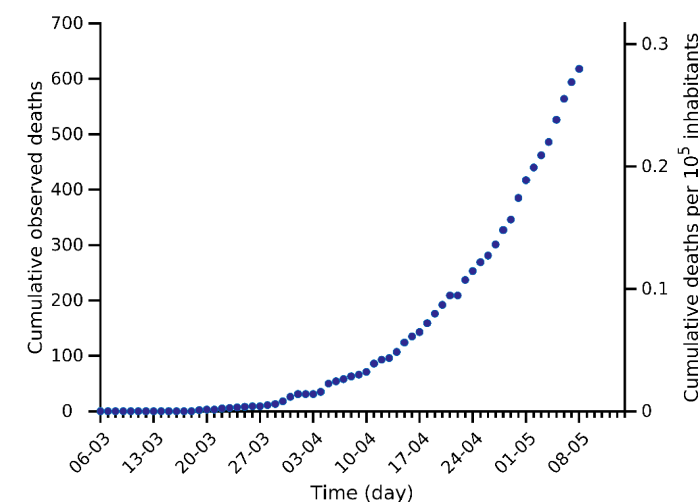
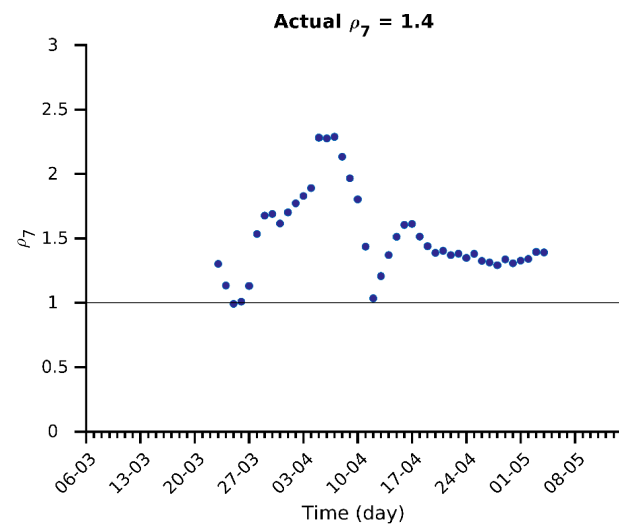
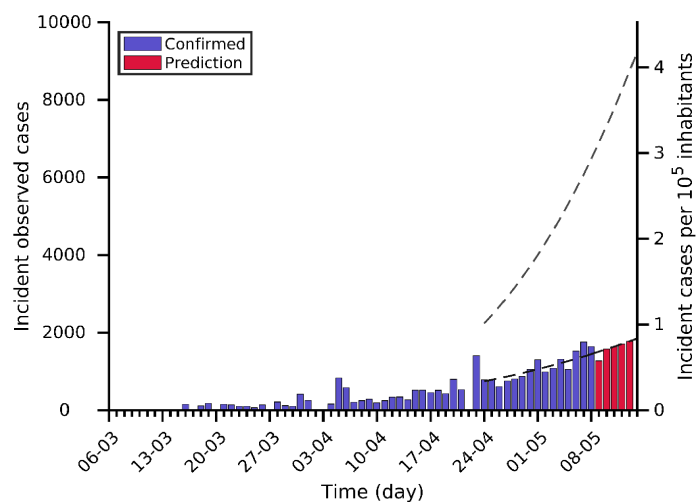
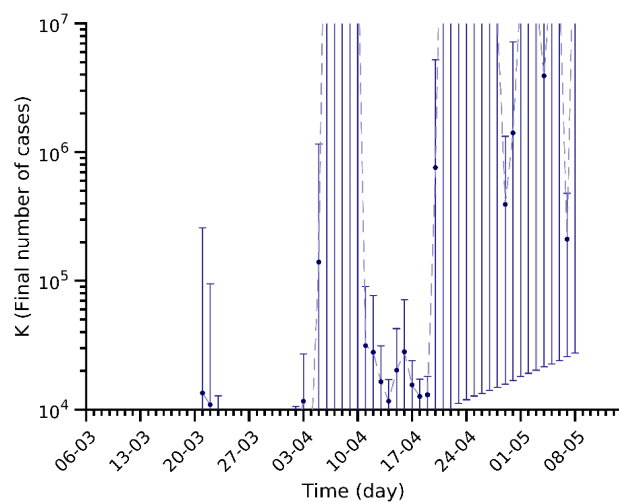
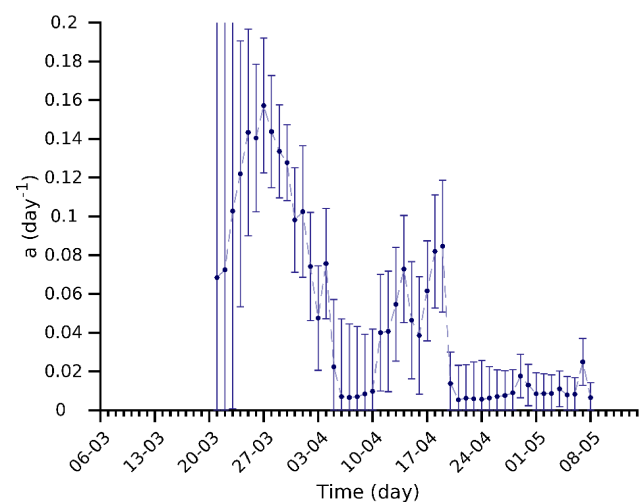
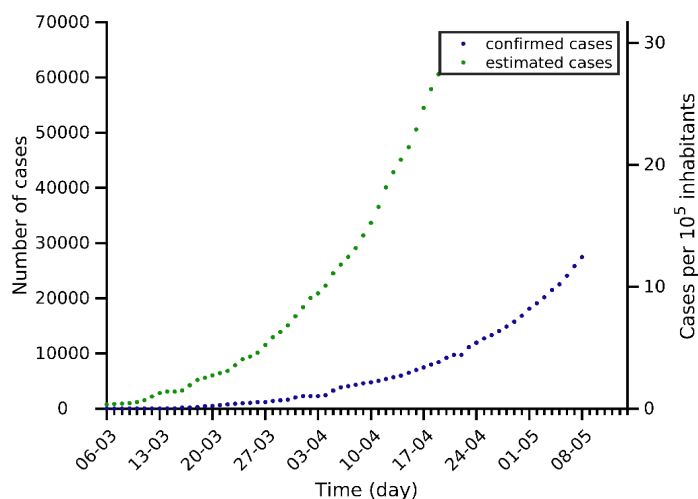
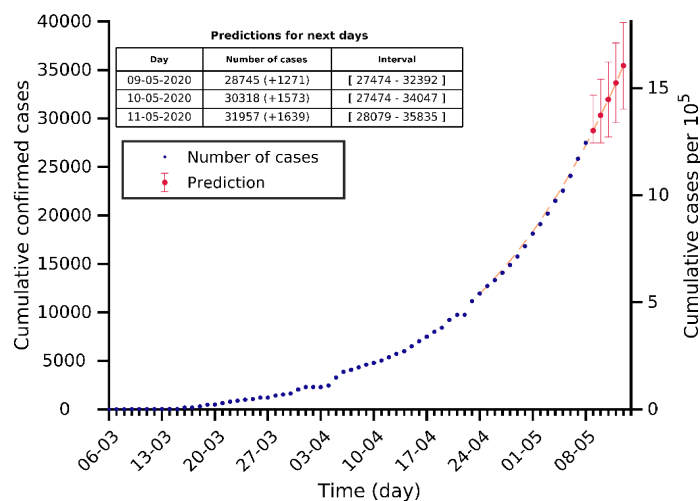


# Ecuador 08-05-2020. Population: 17.6M. Current cumulated incidence: 163/10<sup>5</sup>

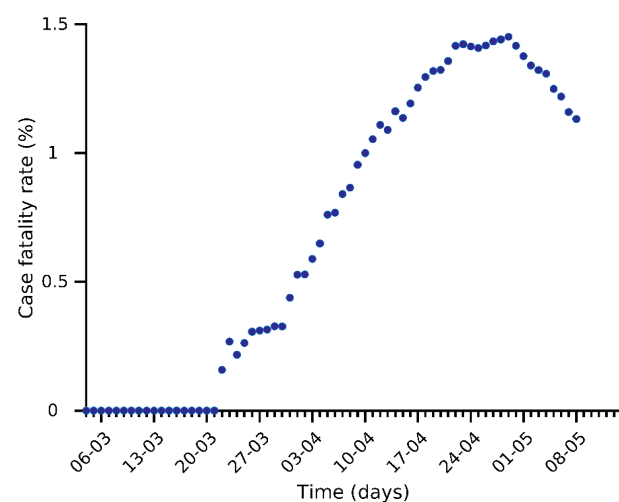
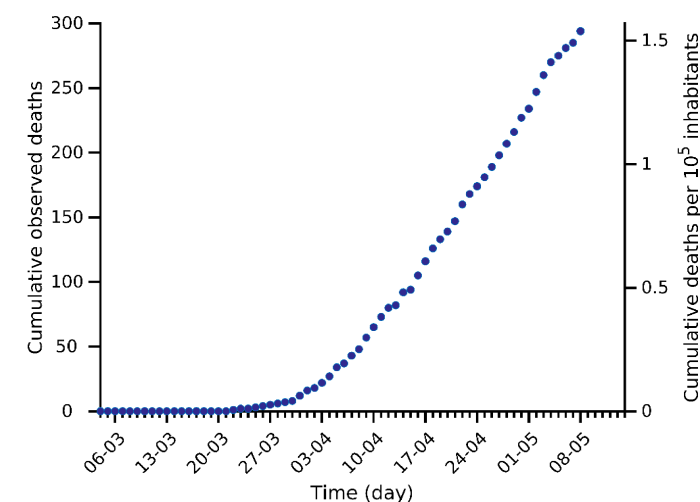
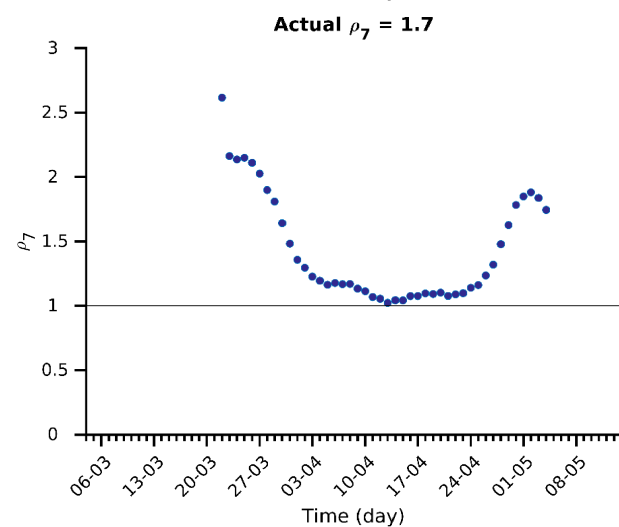
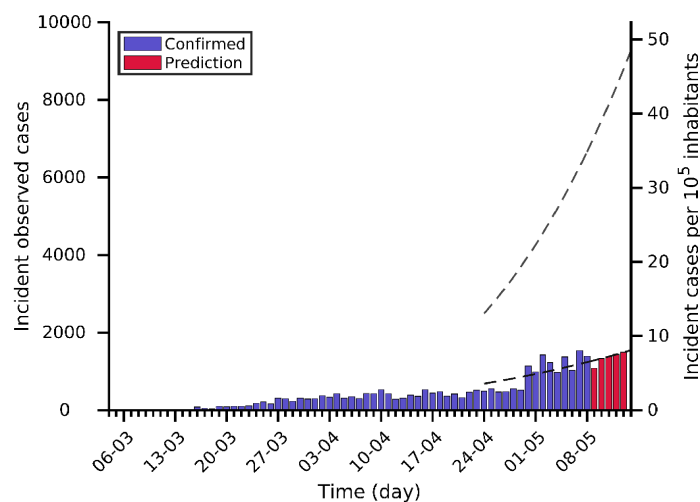
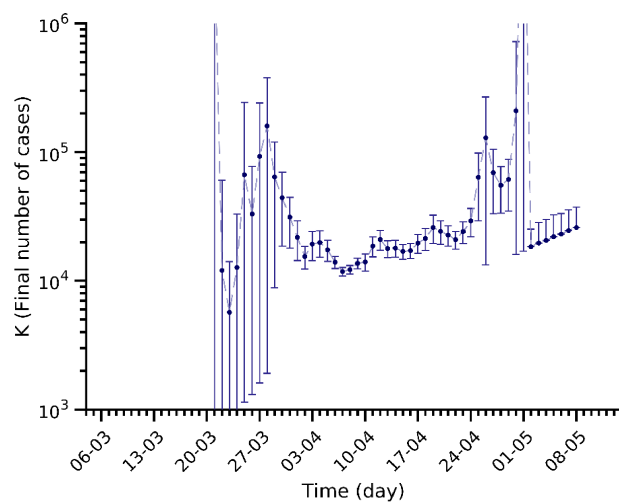
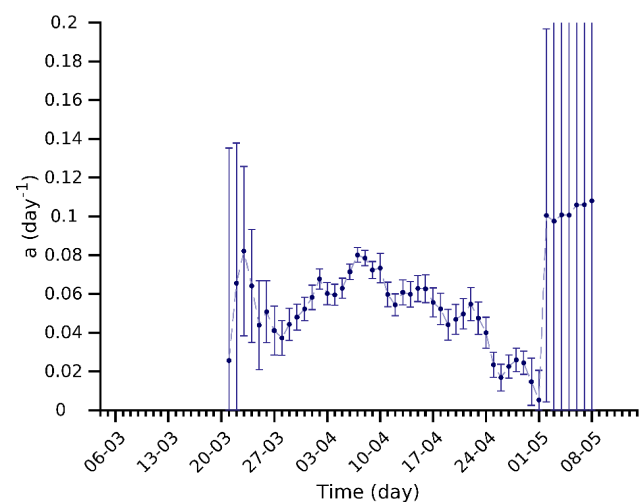
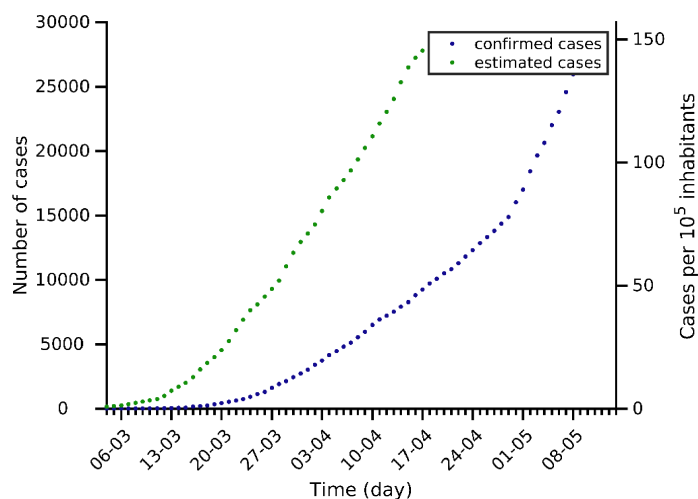
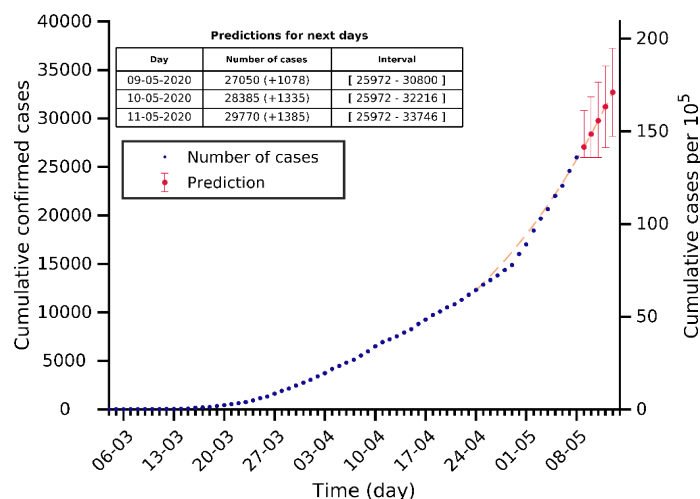




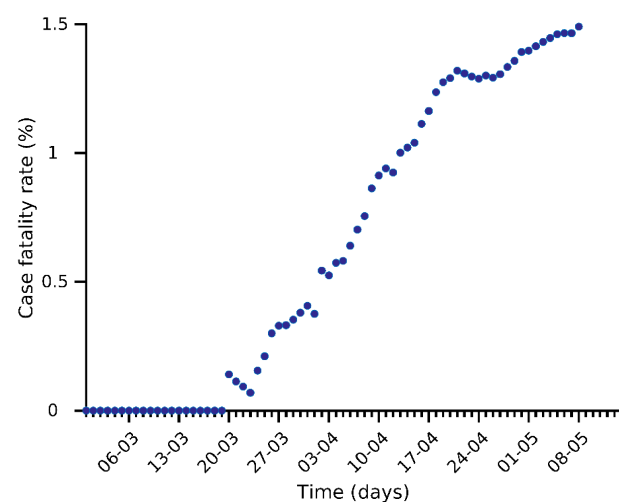
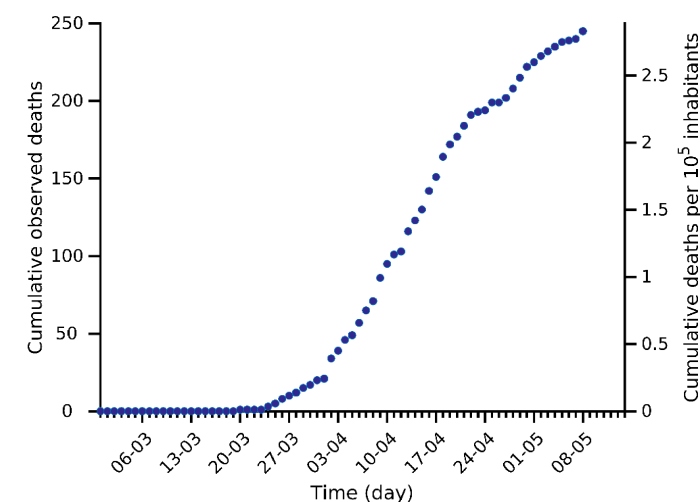
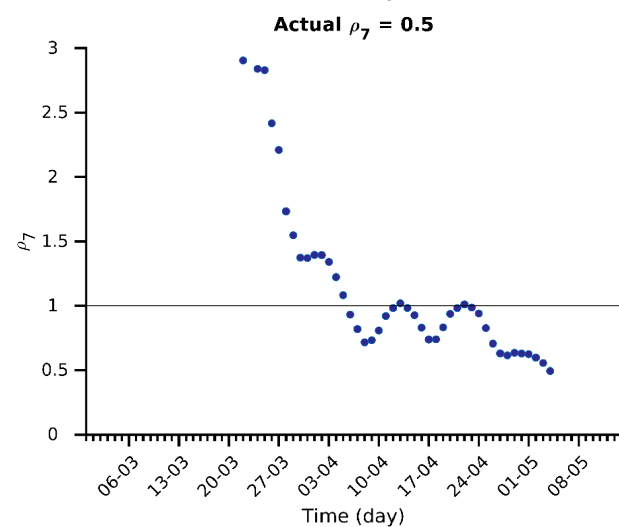
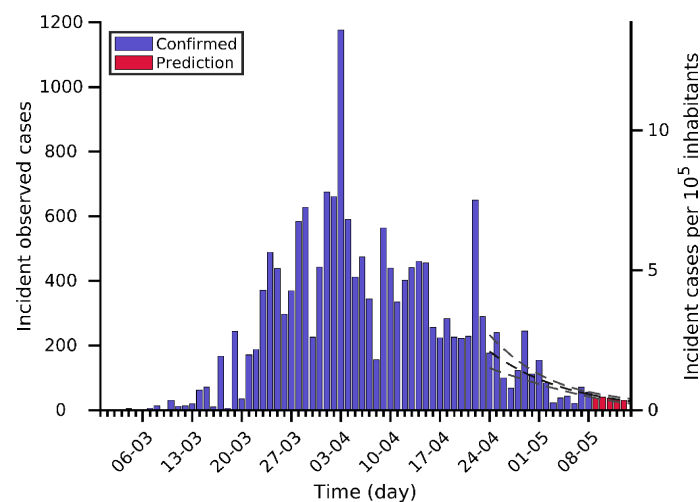
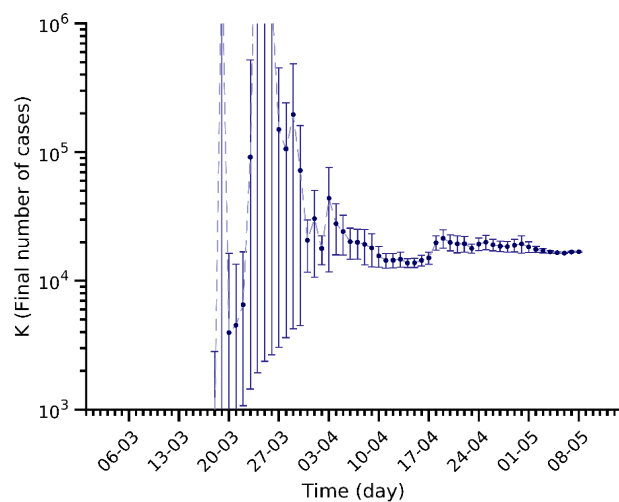
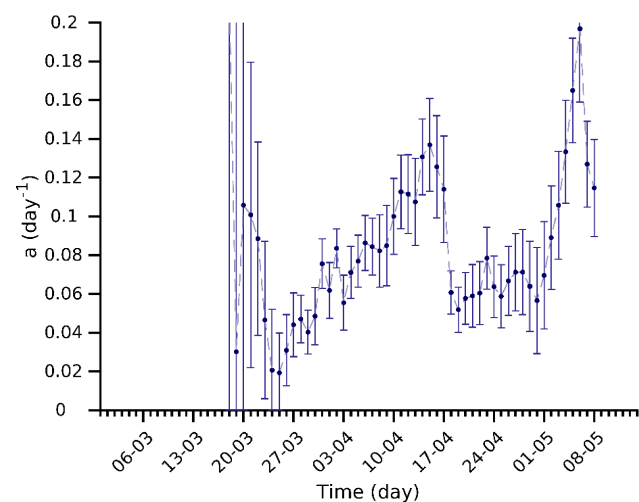
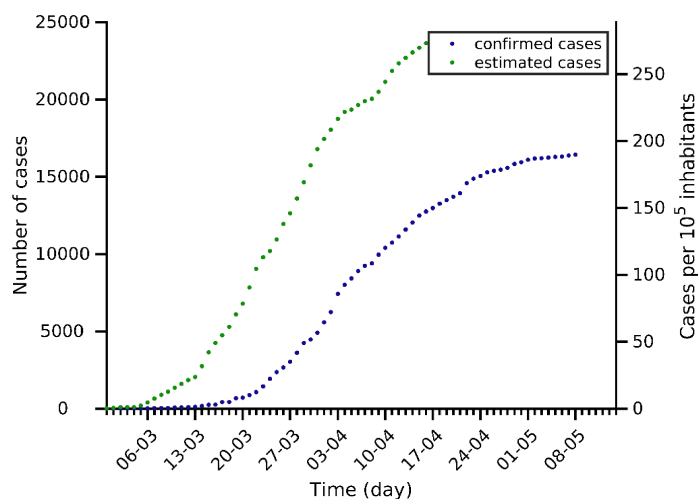
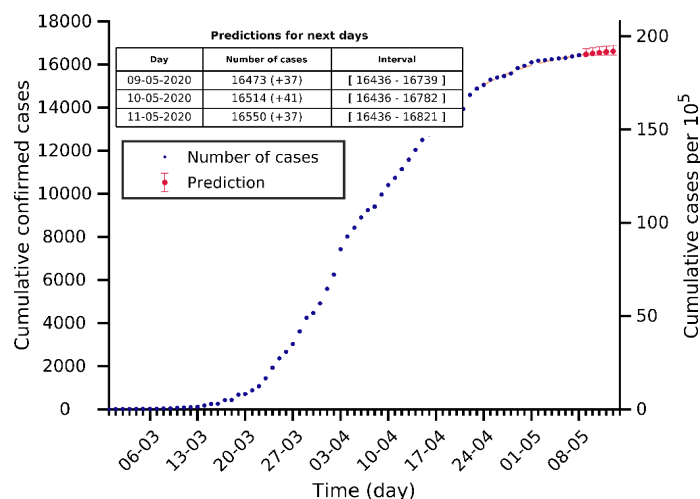
# Pakistan 08-05-2020. Population: 220.9M. Current cumulated incidence: 12/10<sup>5</sup>



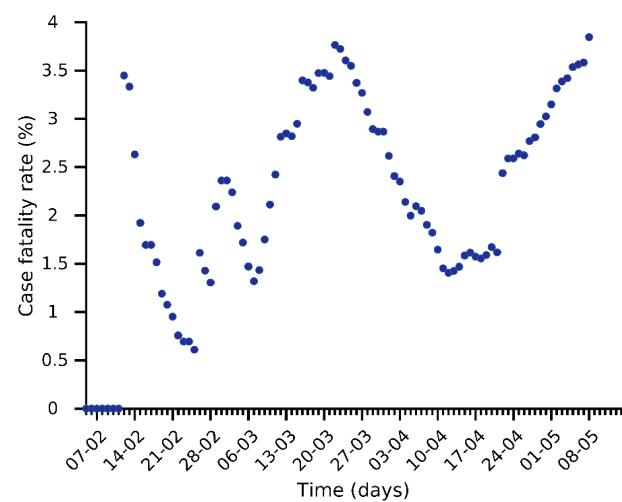
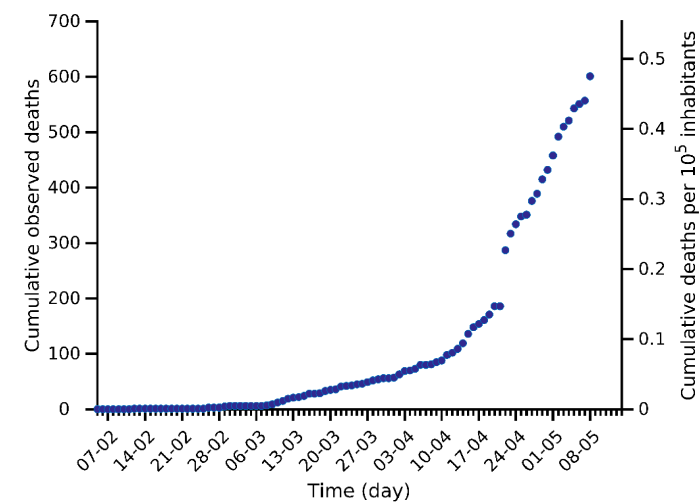
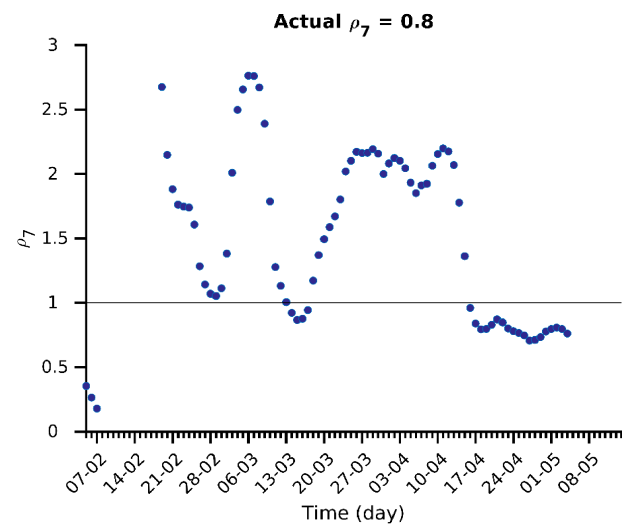
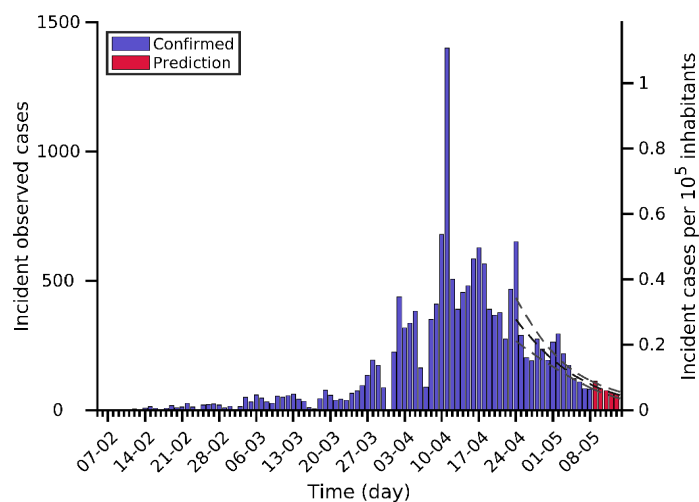
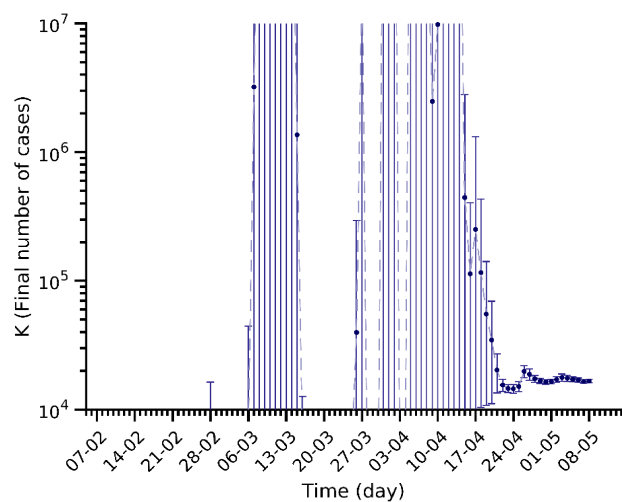
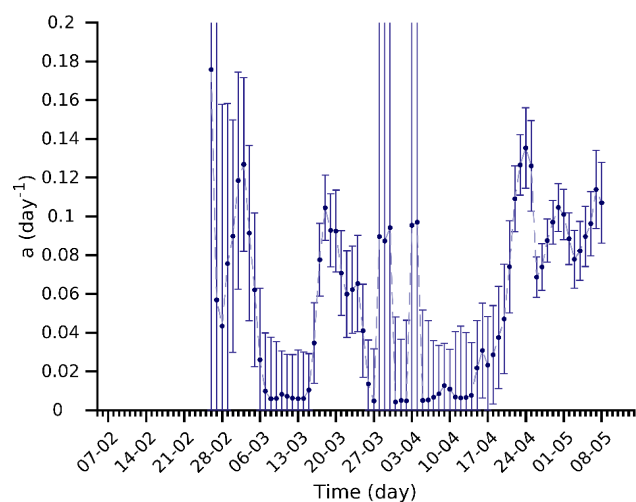
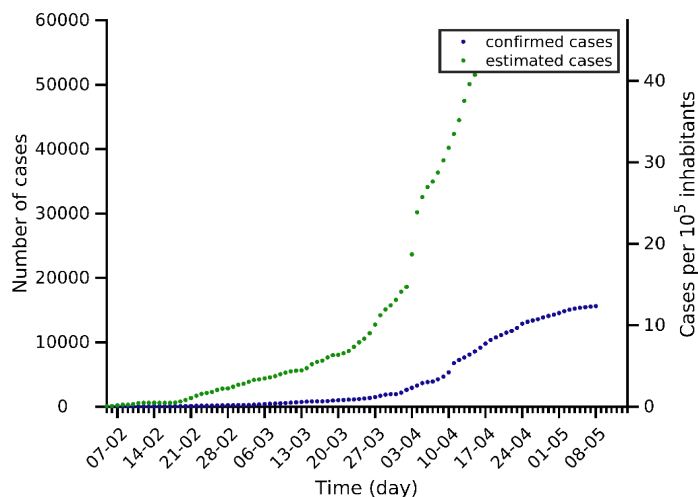
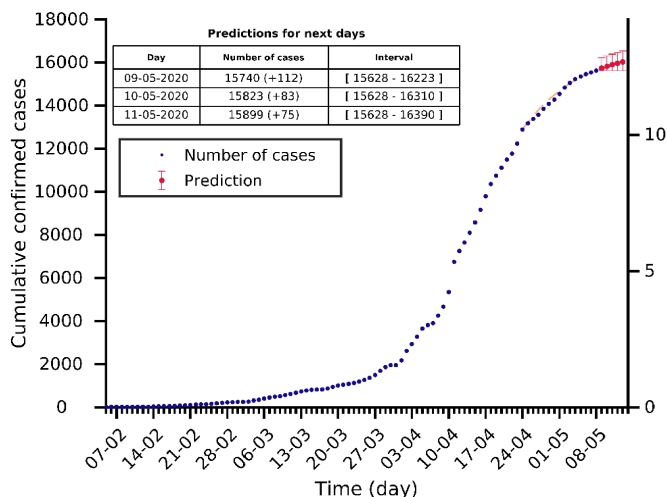
# Chile 08-05-2020. Population: 19.1M. Current cumulated incidence: 136/10<sup>5</sup>



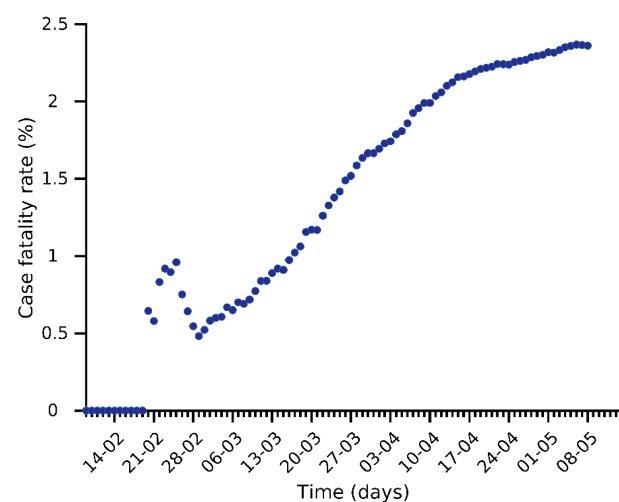
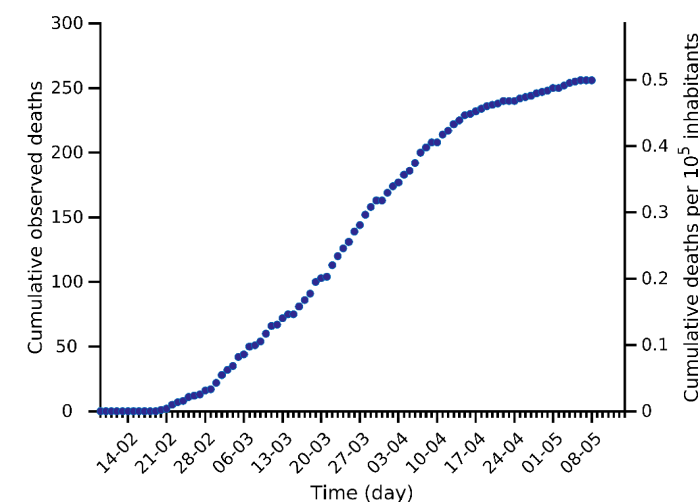
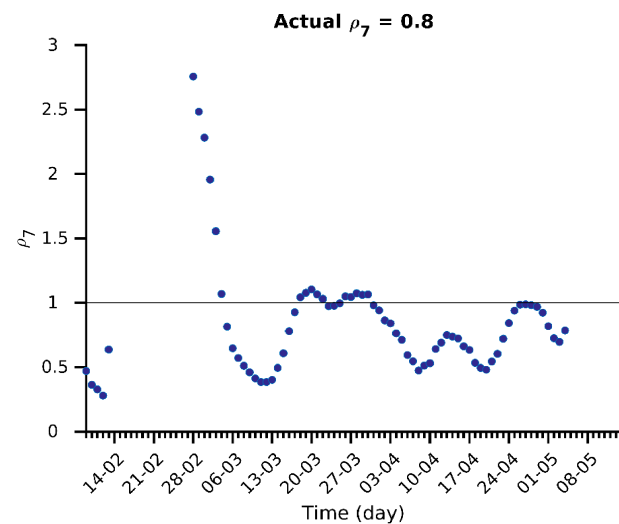
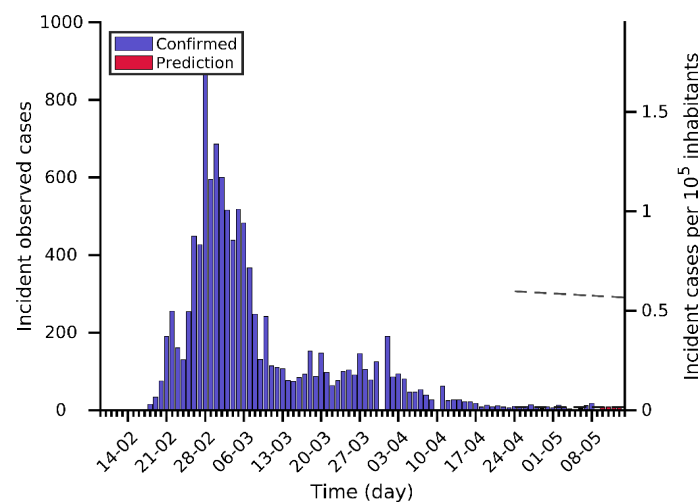
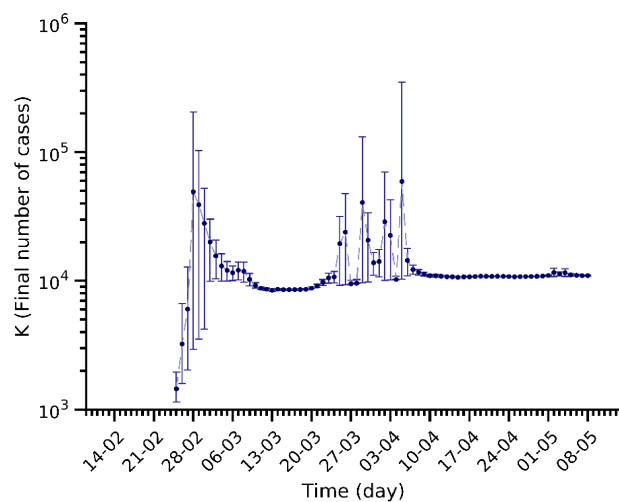
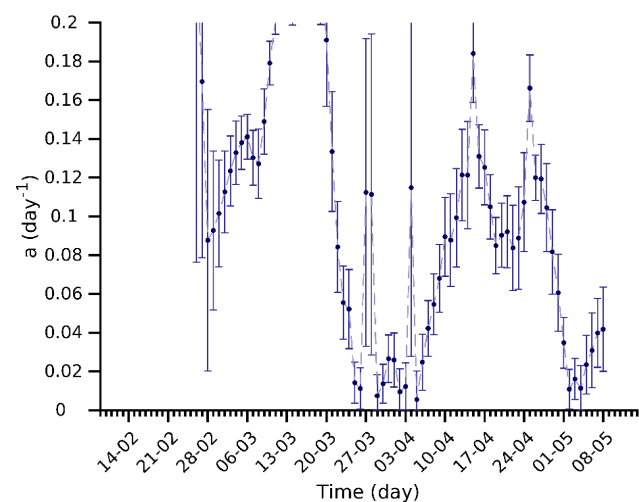
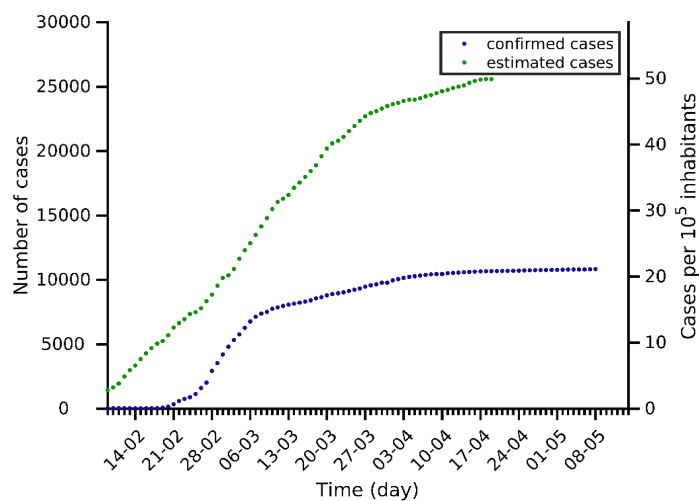
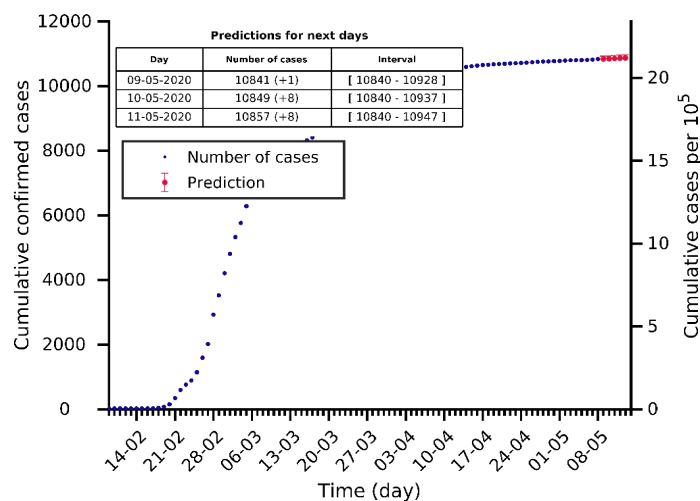
# Israel 08-05-2020. Population: 8.7M. Current cumulated incidence: 190/10<sup>5</sup>



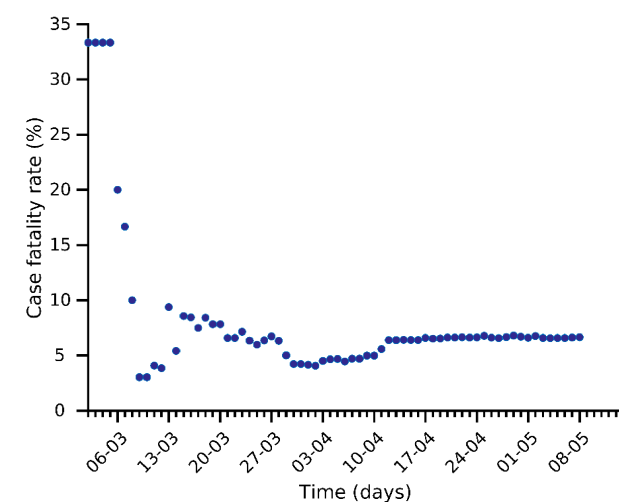
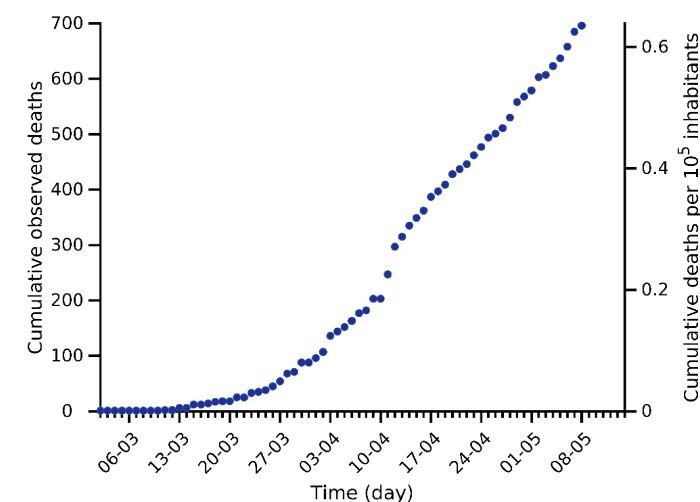
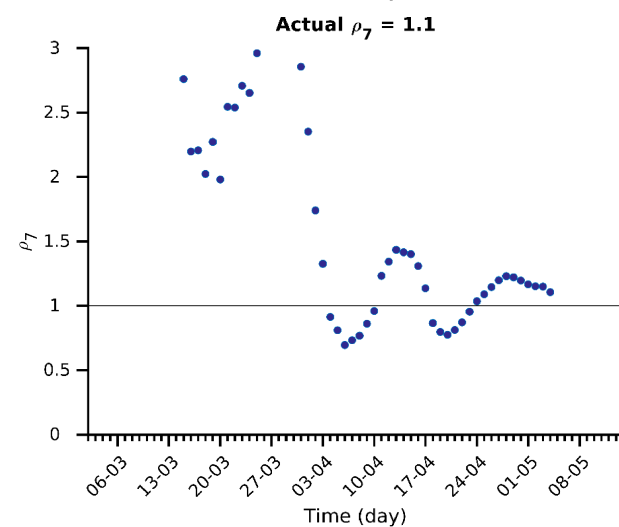
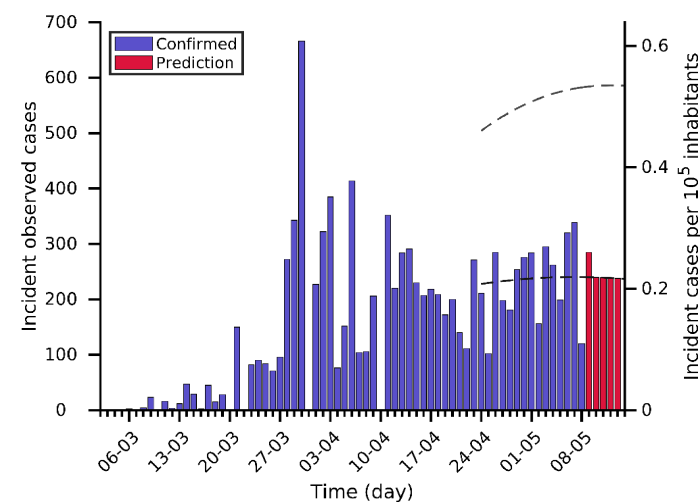
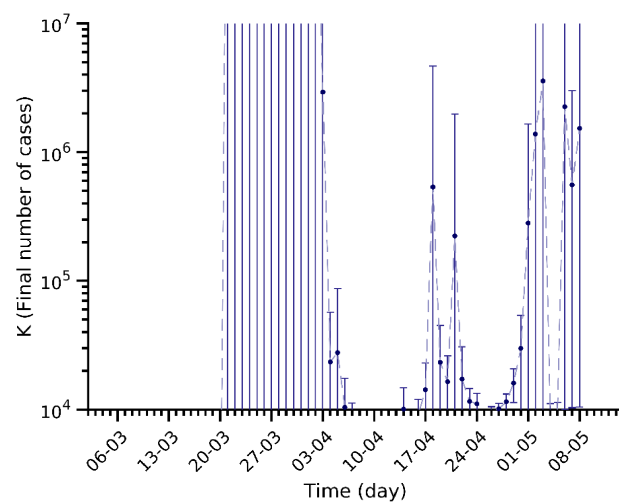
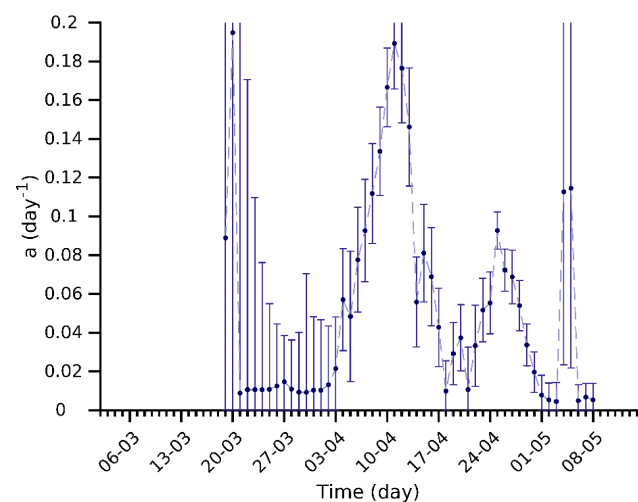
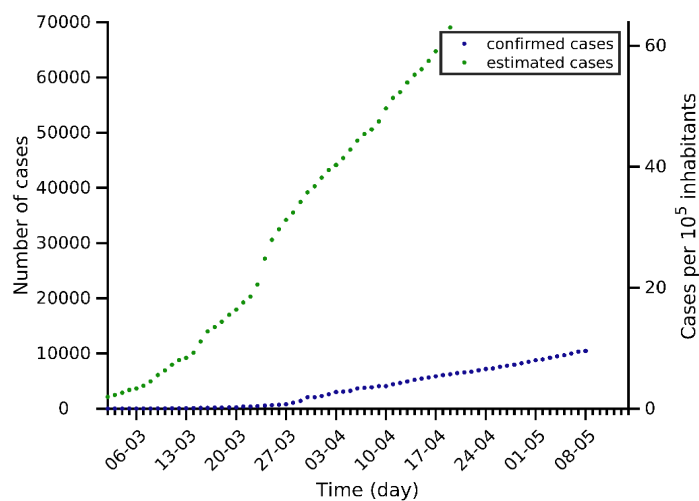
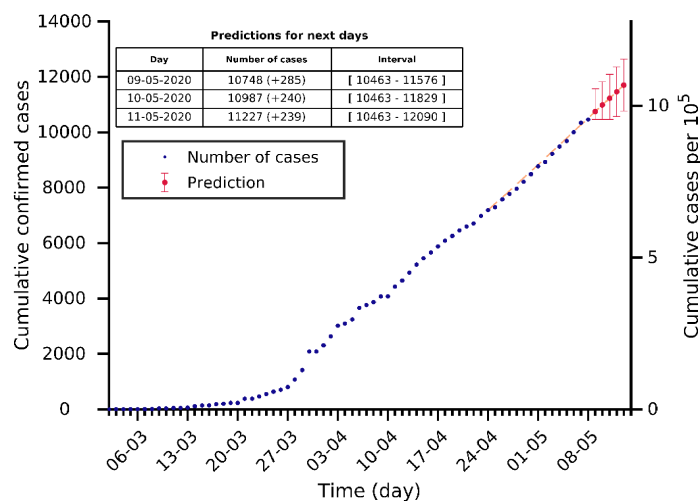
# Japan 08-05-2020. Population: 126.5M. Current cumulated incidence: 12/10<sup>5</sup>



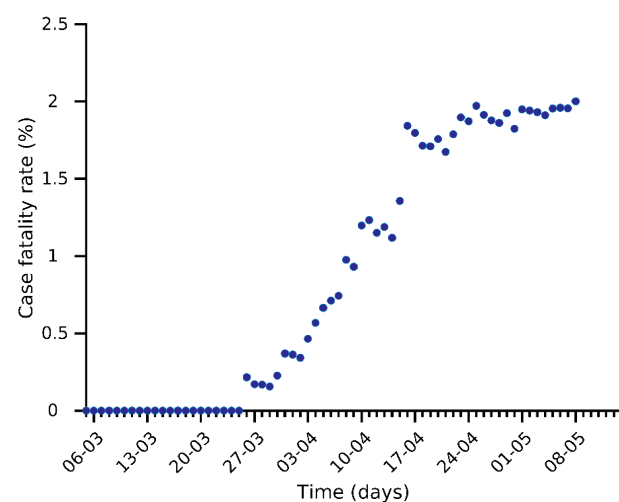
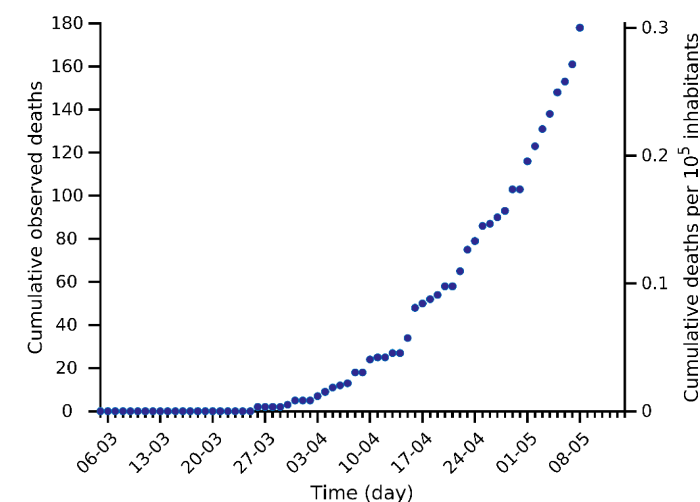
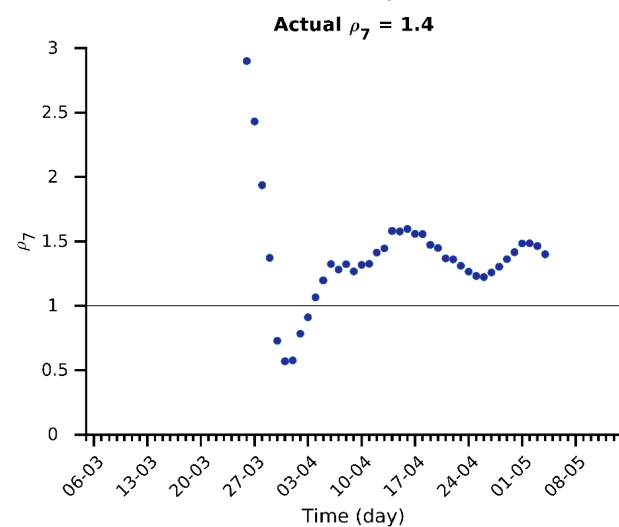
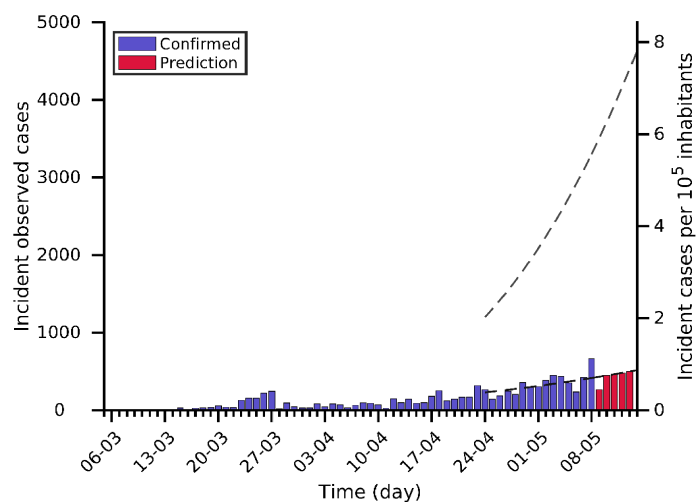
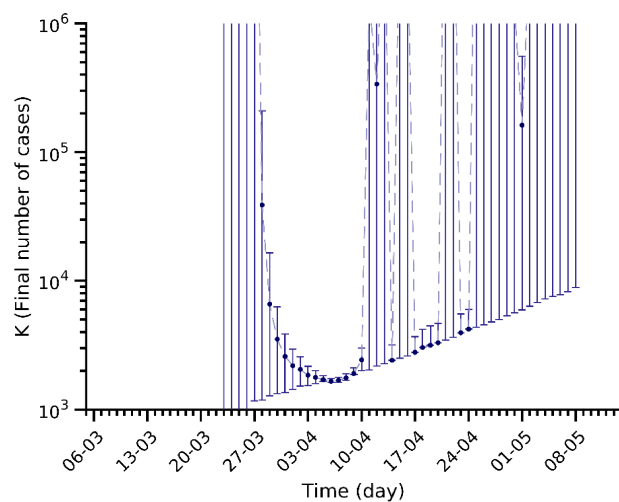
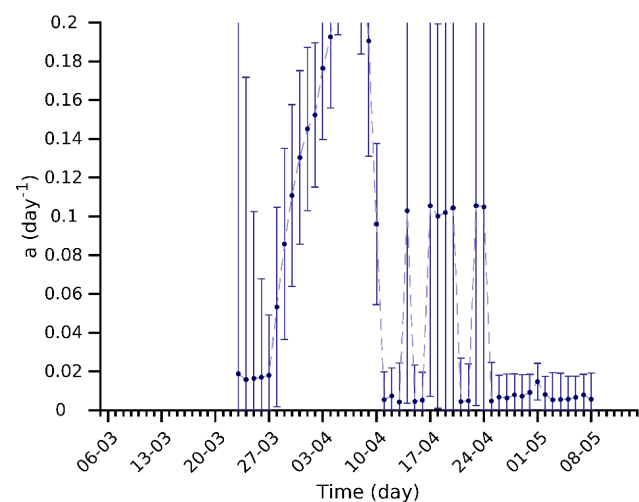
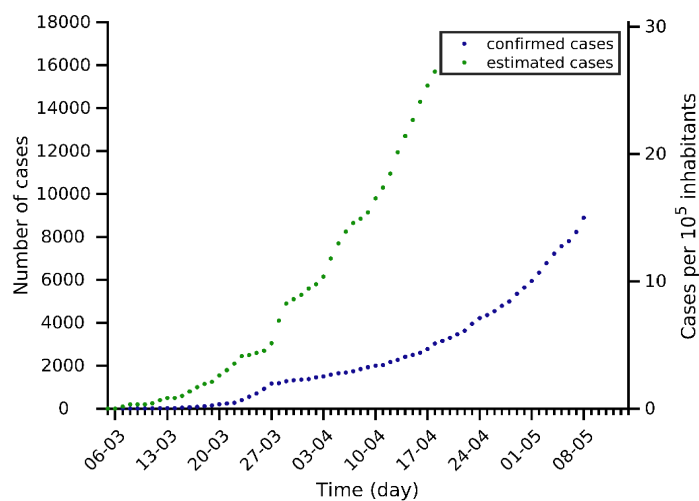
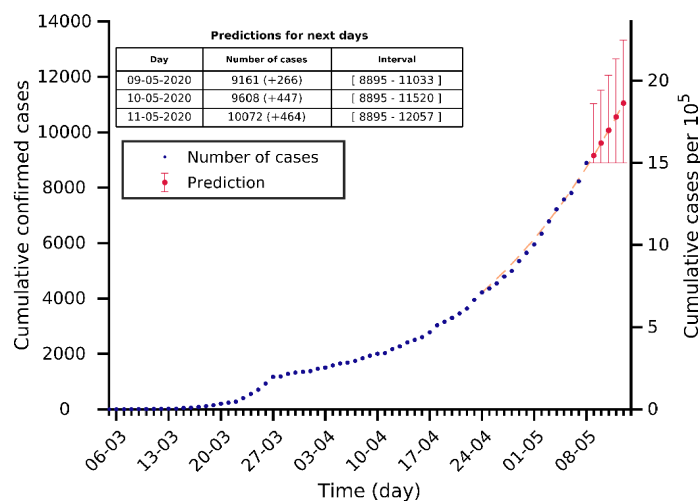
# South Korea 08-05-2020. Population: 51.3M. Current cumulated incidence: 21/10<sup>5</sup>



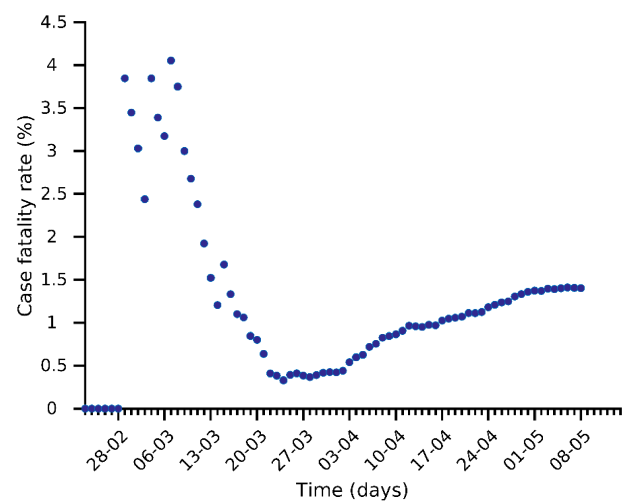
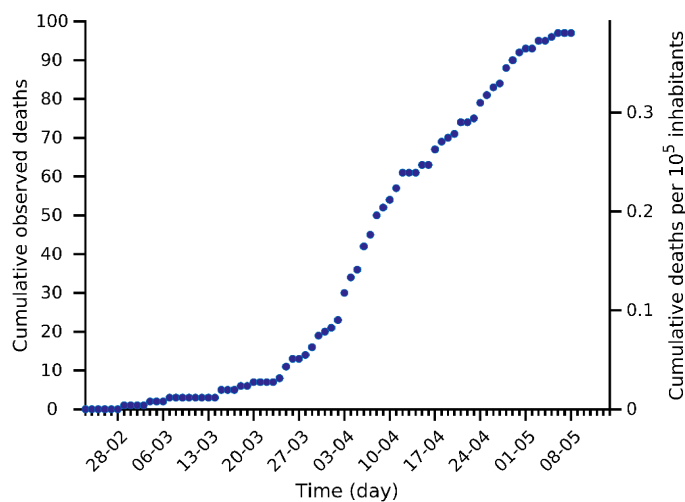
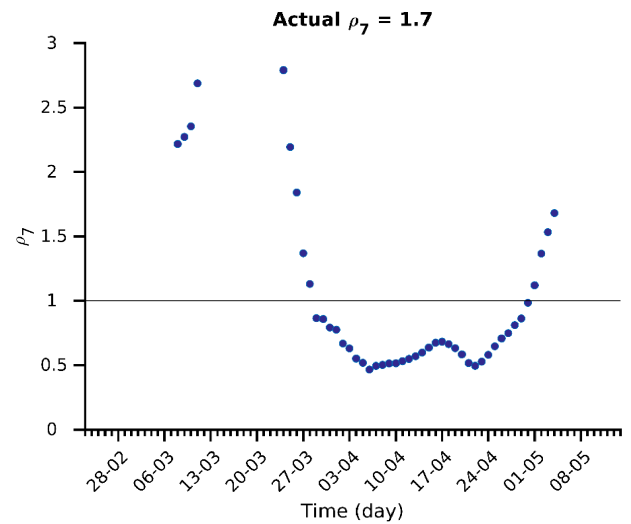
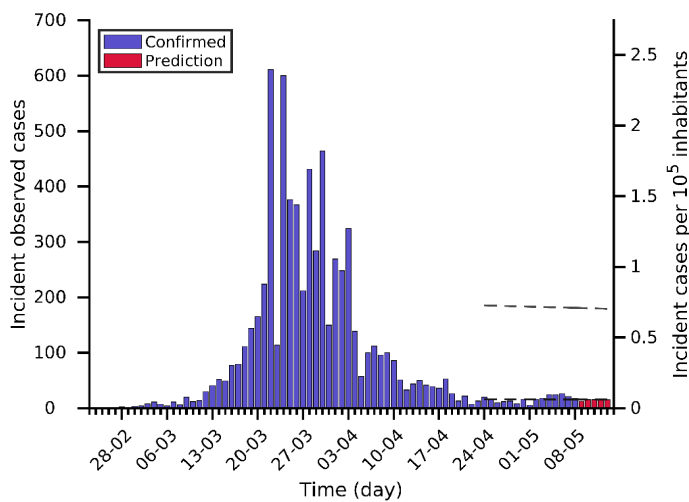
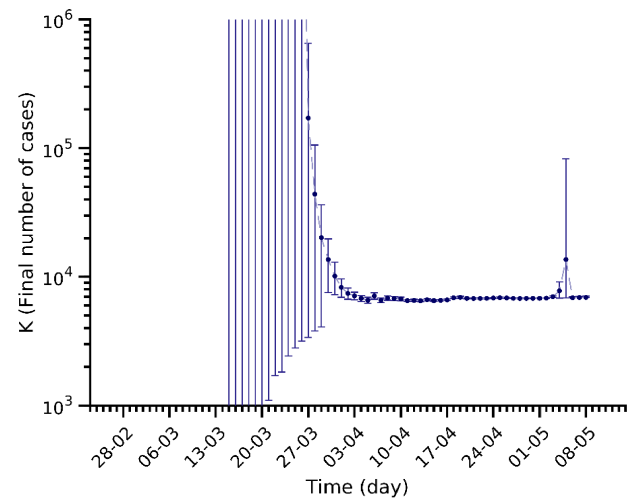
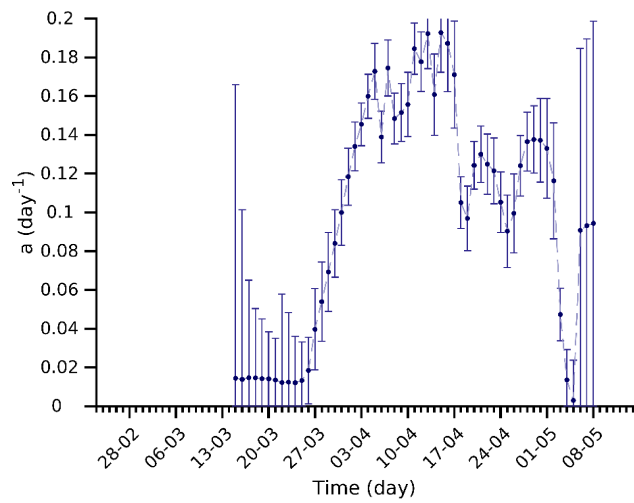
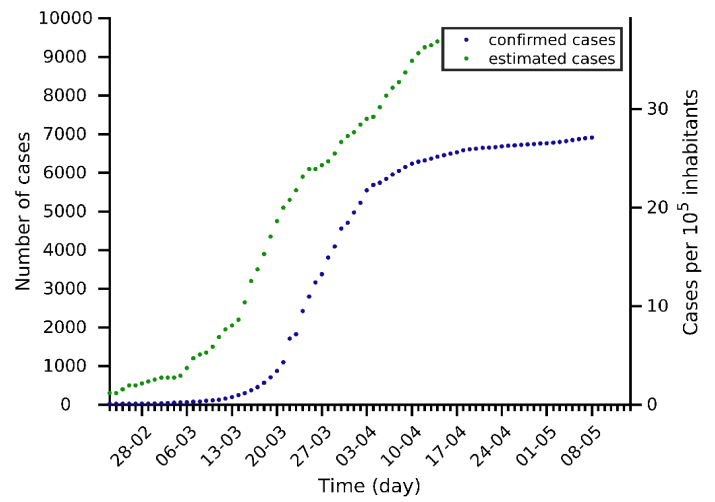
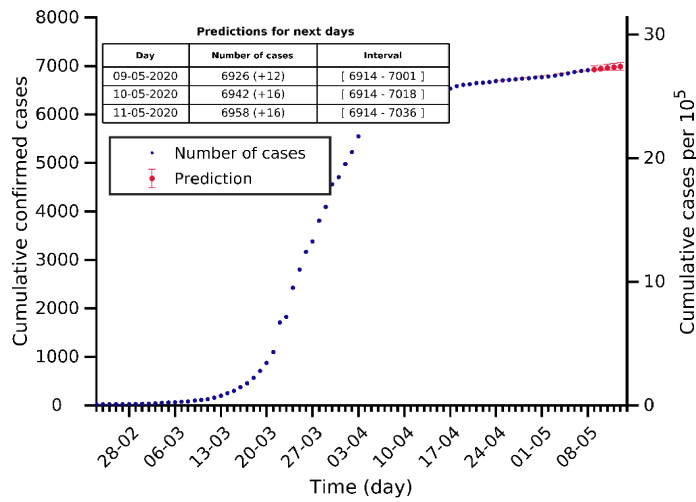
# Philippines 08-05-2020. Population: 109.6M. Current cumulated incidence: 10/10<sup>5</sup>



# South Africa 08-05-2020. Population: 59.3M. Current cumulated incidence: 15/10<sup>5</sup>

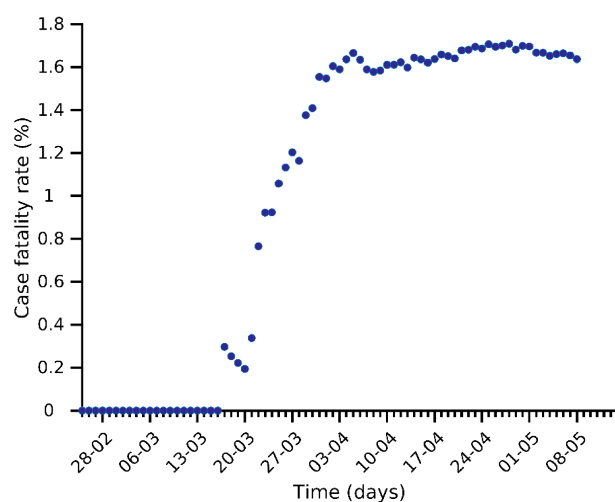
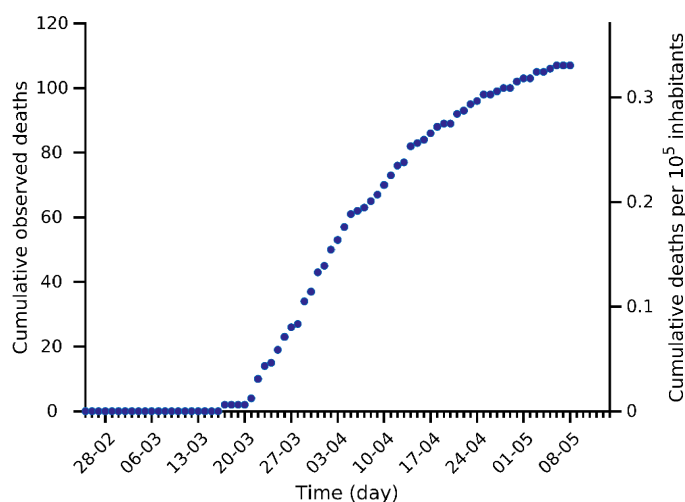
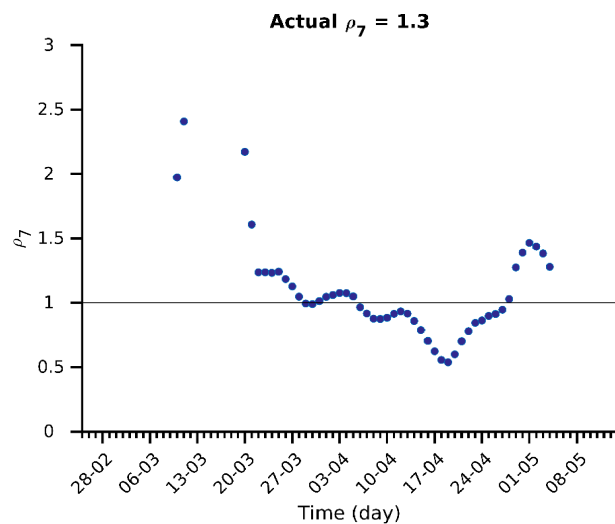
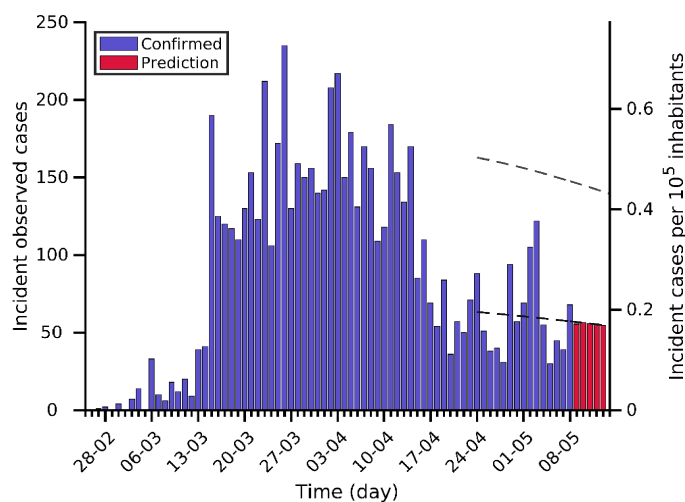
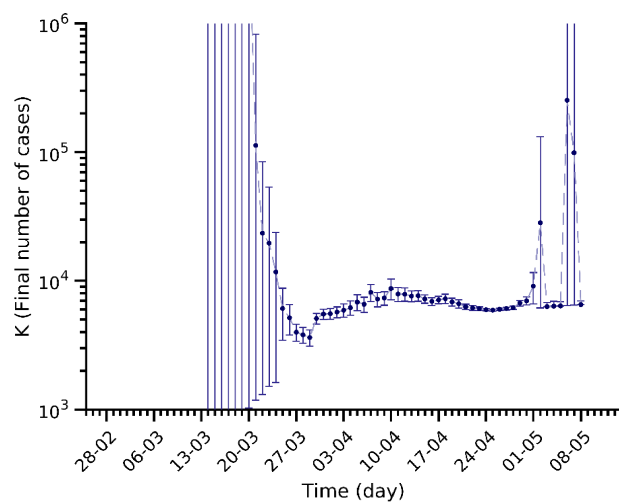
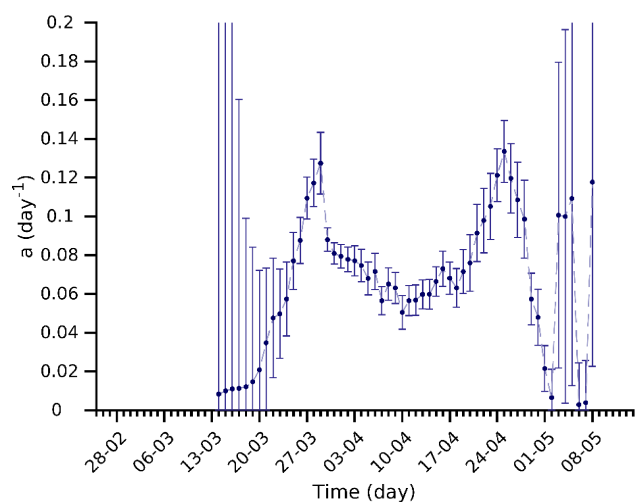
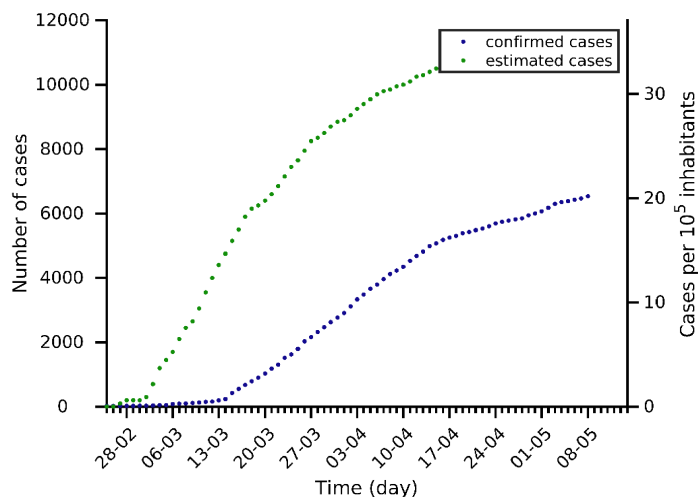
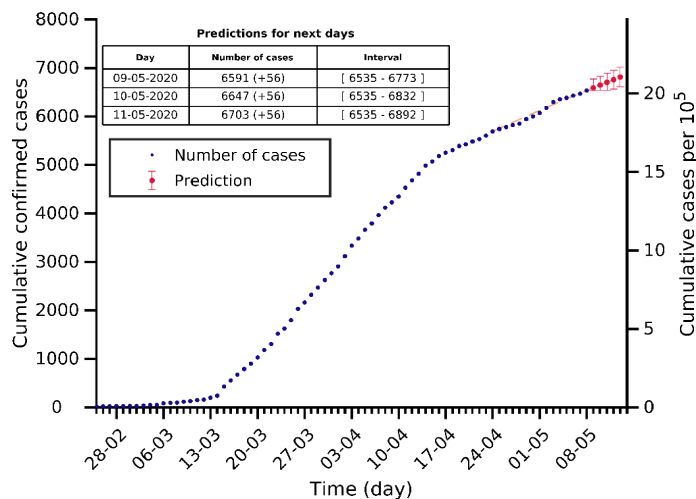


# Australia 08-05-2020. Population: 25.5M. Current cumulated incidence: $27/10^5$





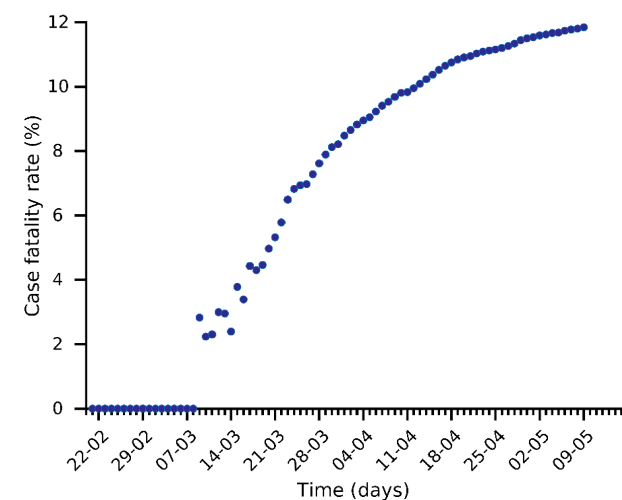
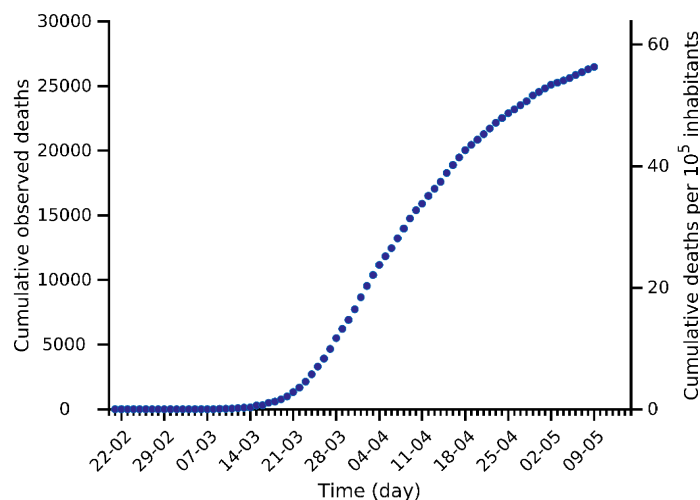
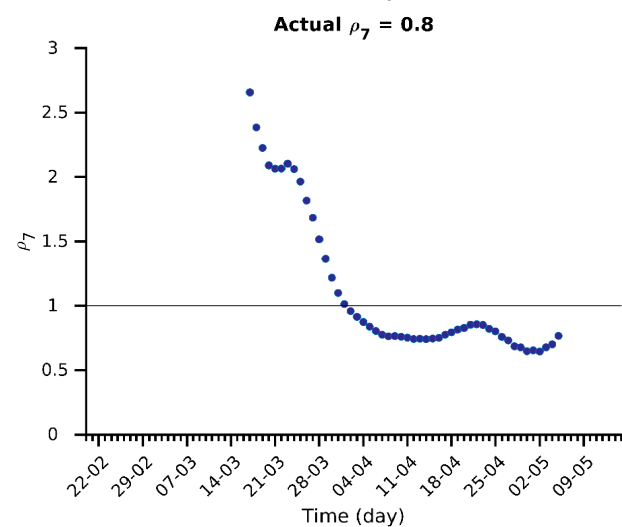
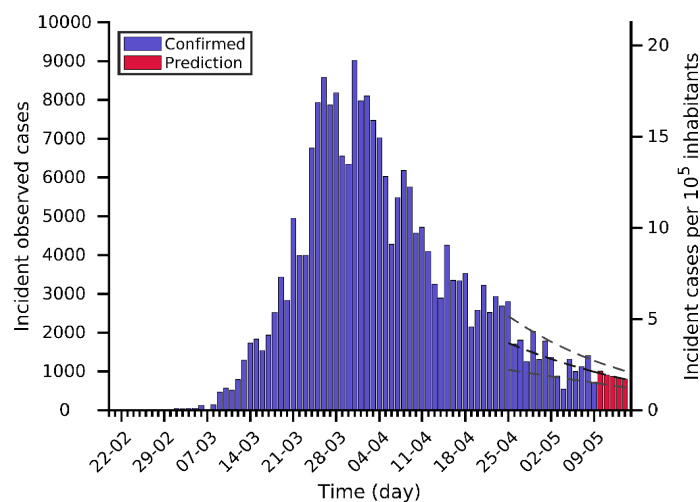
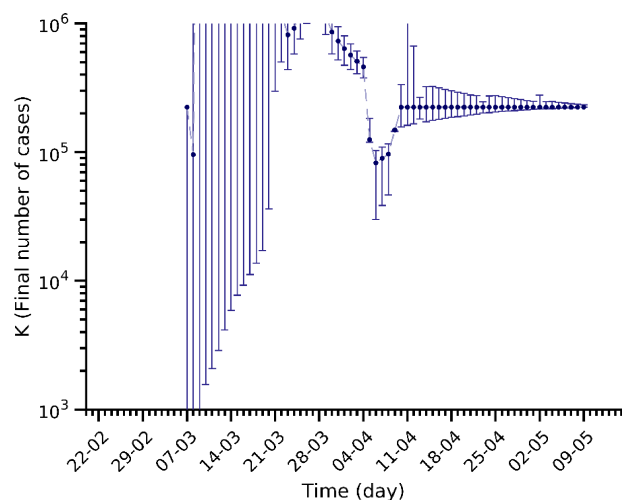
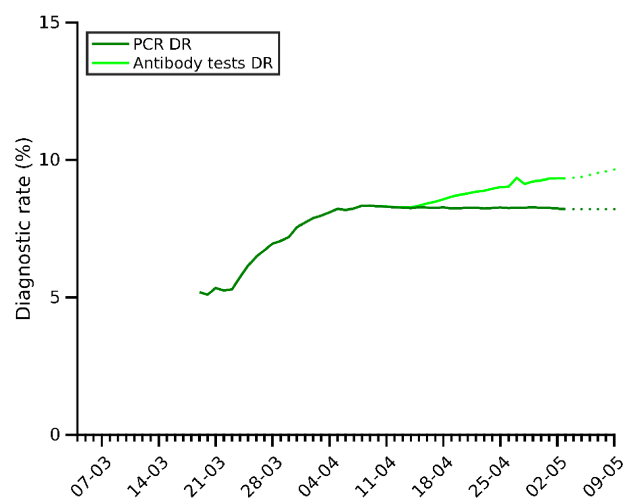
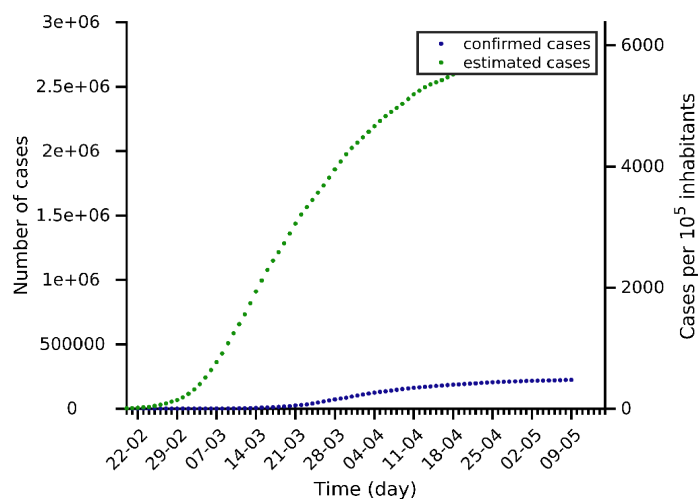
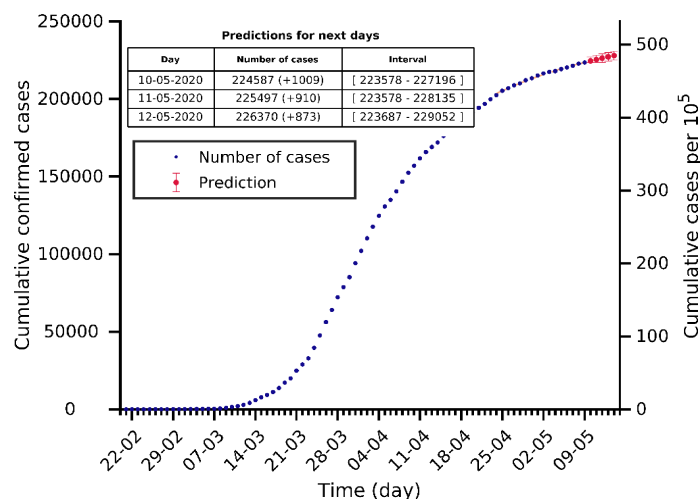
# Malaysia 08-05-2020. Population: 32.4M. Current cumulated incidence: 20/10<sup>5</sup>



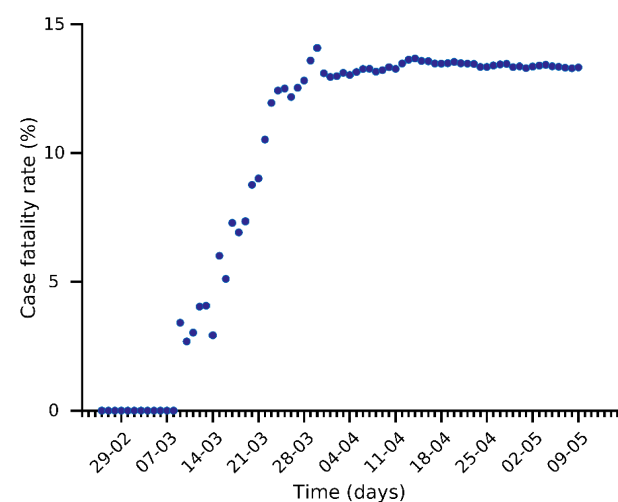
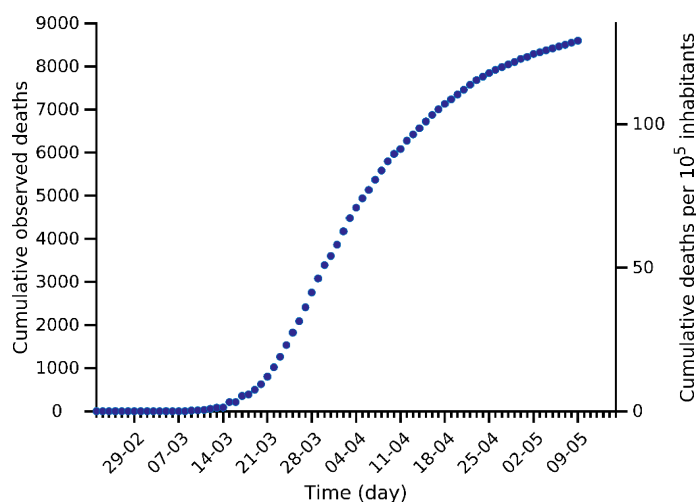
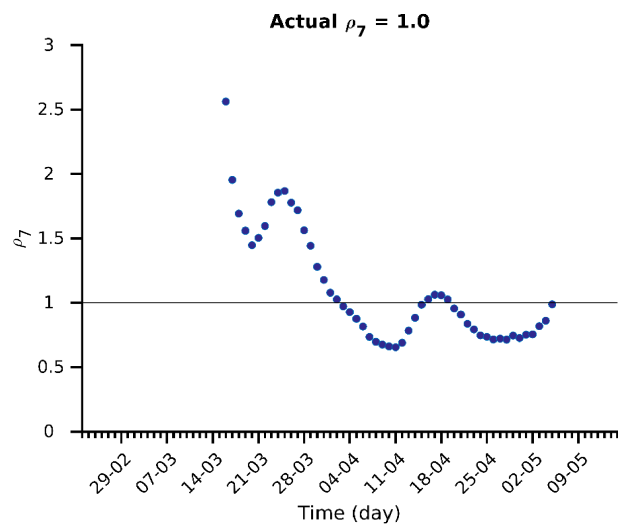
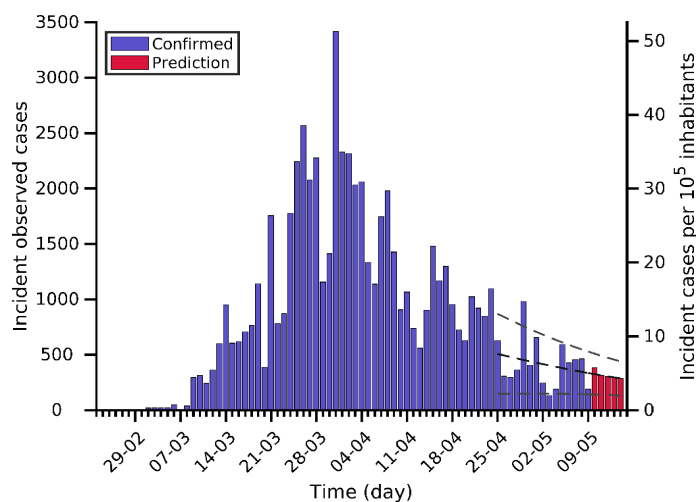
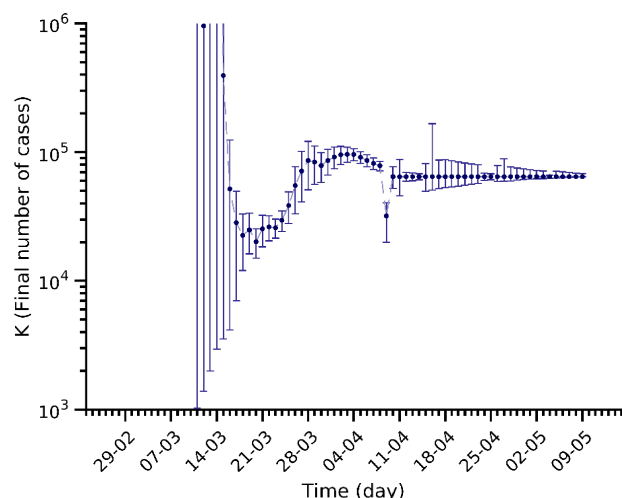
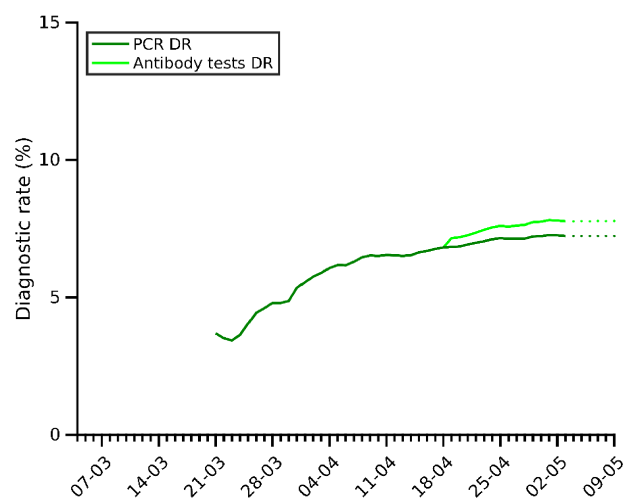
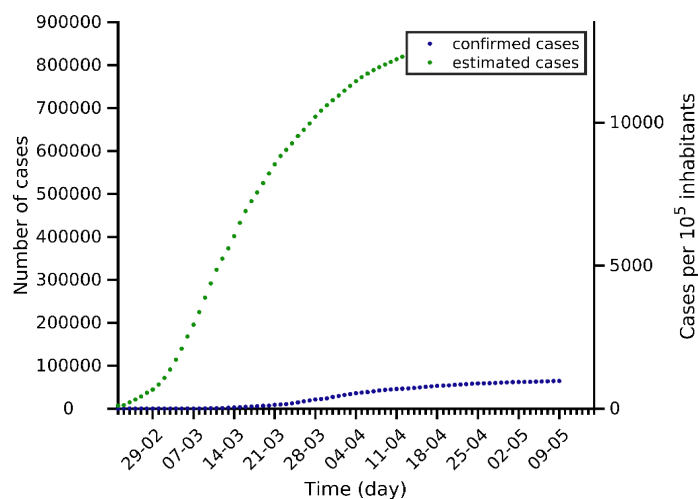
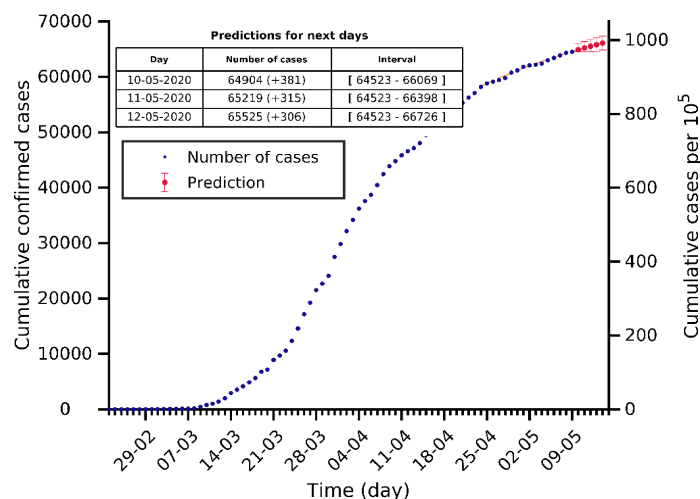
### **(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities**

Data obtained from <https://github.com/datadista/datasets/tree/master/COVID%2019> and  
<https://covid19.isciii.es/>

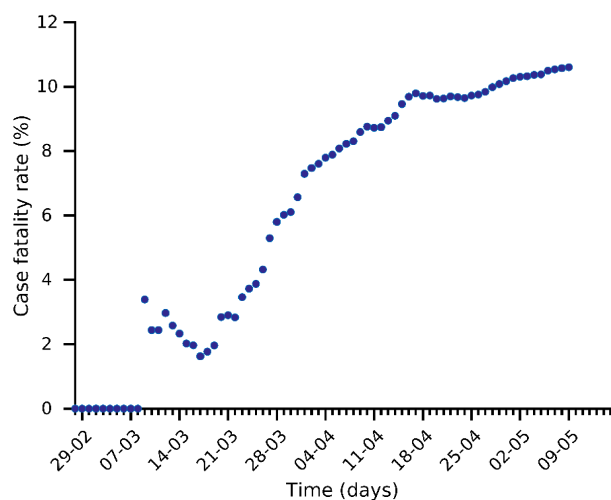
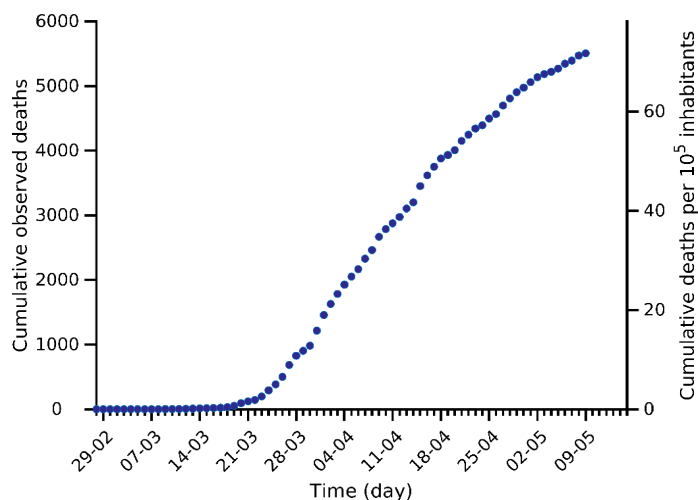
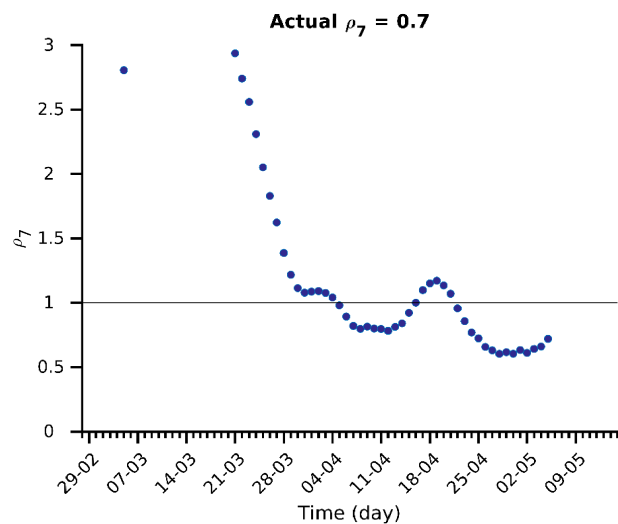
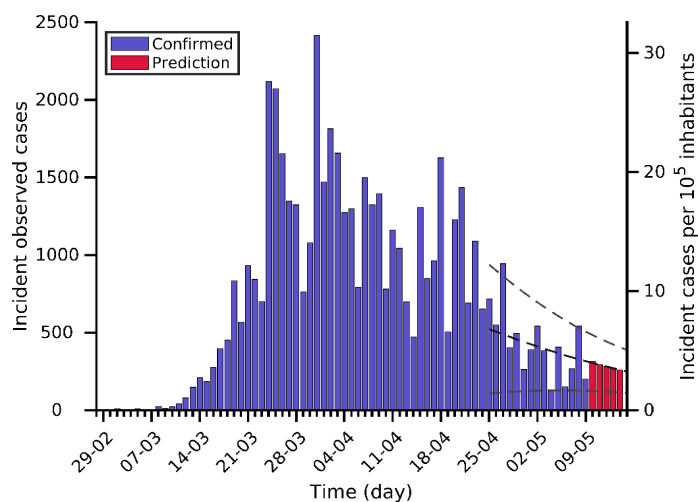
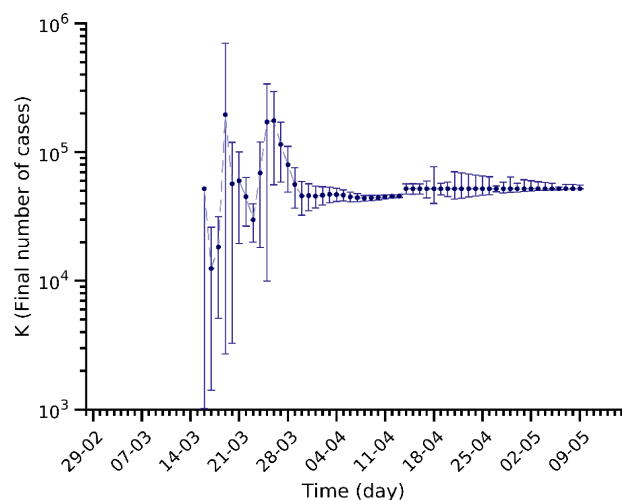
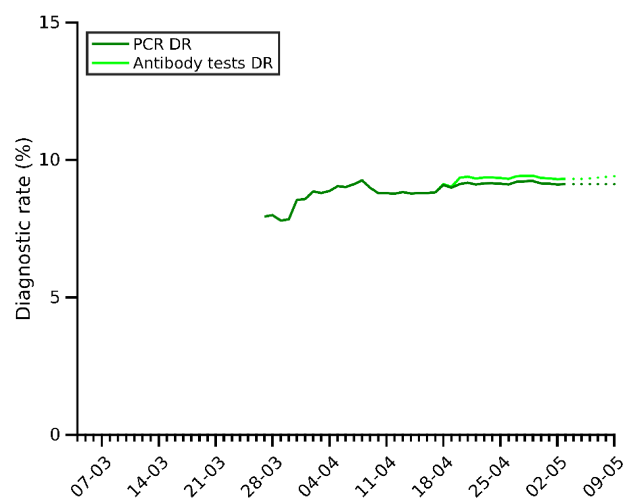
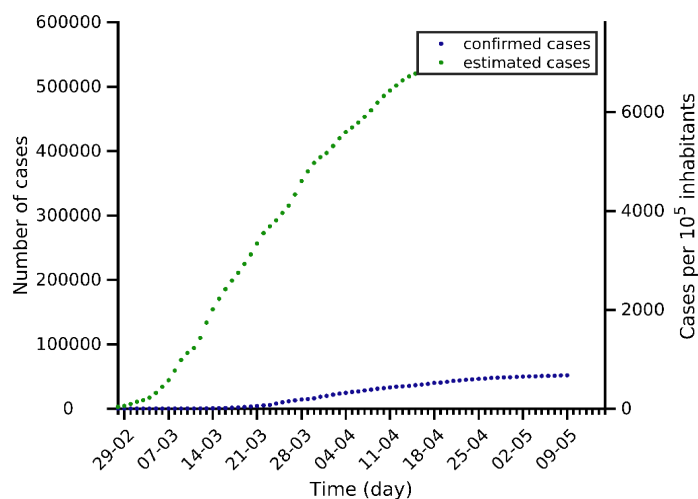
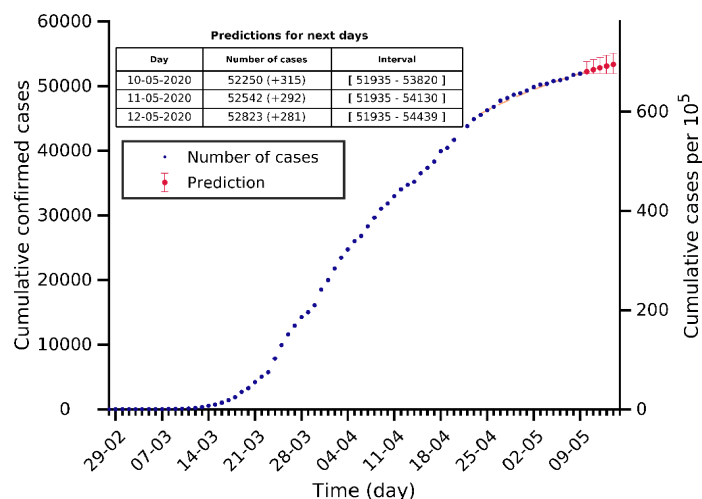
# Spain 09-05-2020. Population: 47.0M. Current cumulated incidence: 475/10<sup>5</sup>



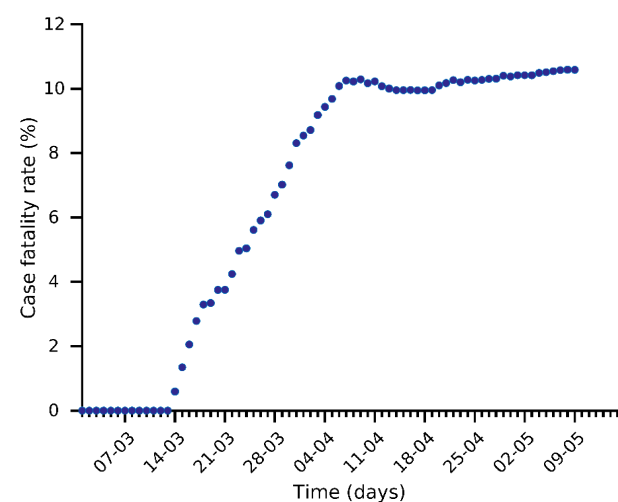
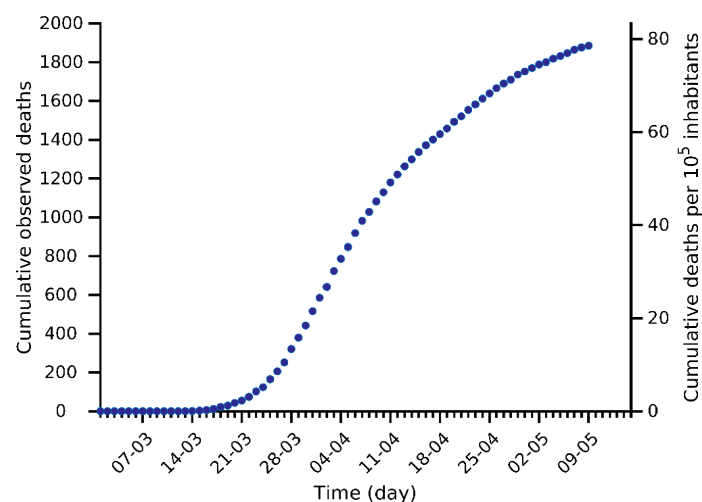
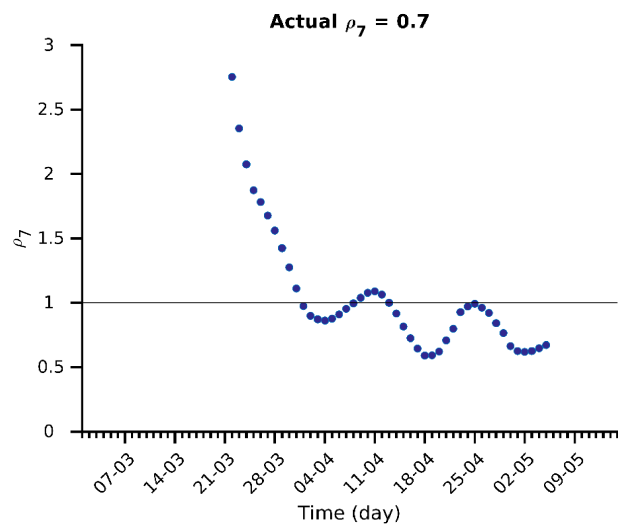
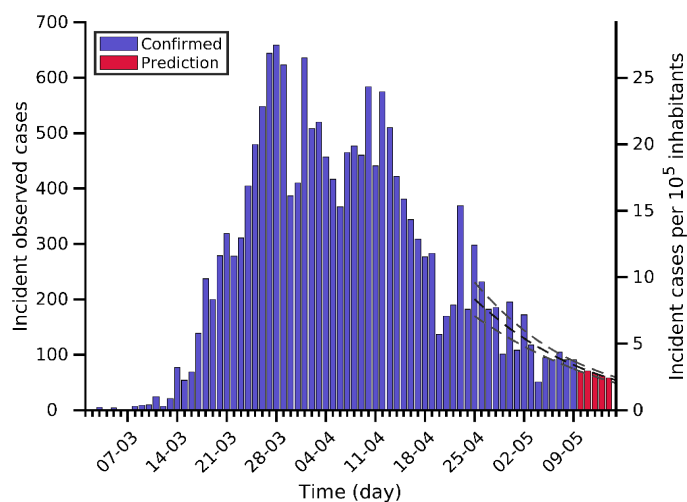
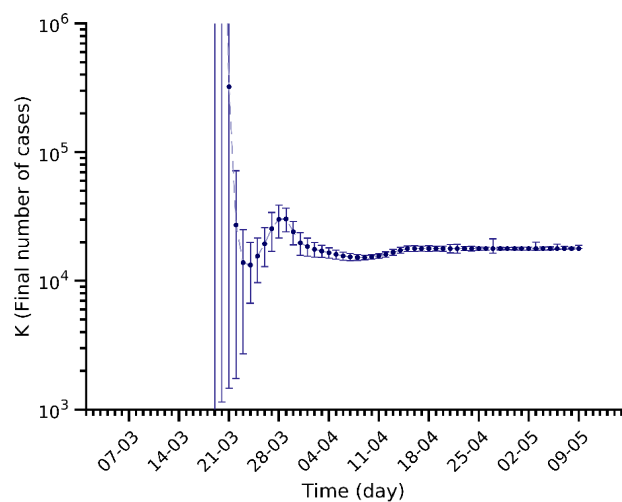
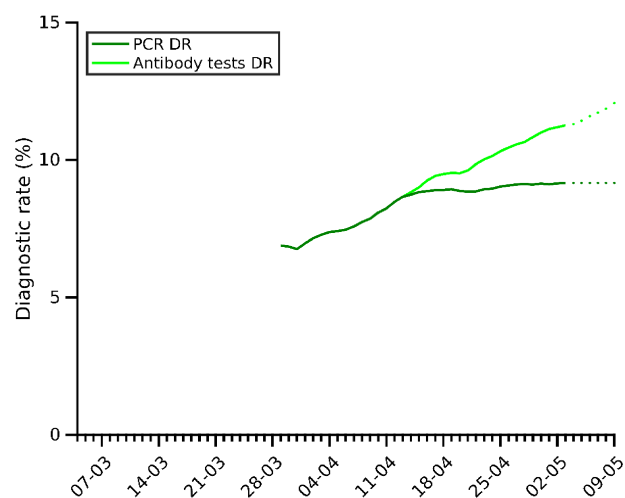
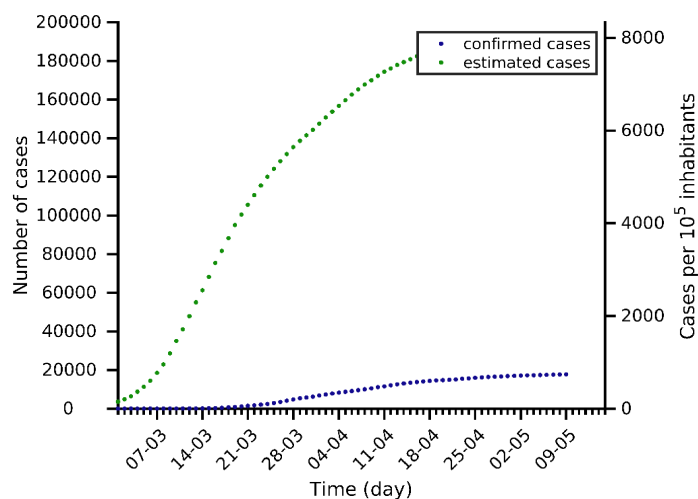
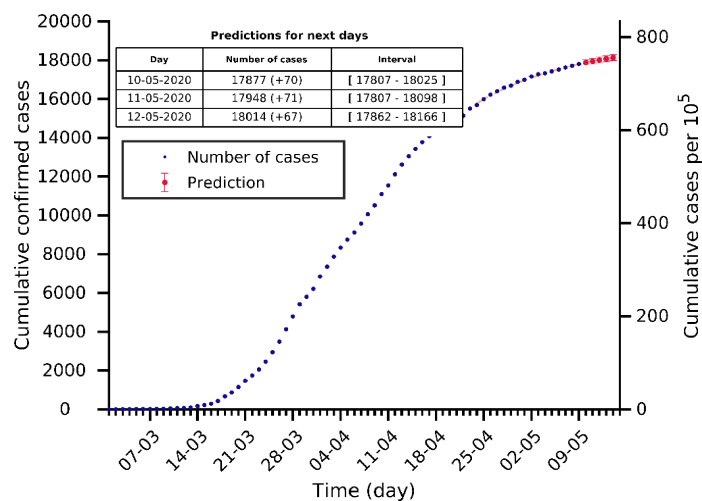
# Madrid 09-05-2020. Population: 6.7M. Current cumulated incidence: 968/10<sup>5</sup>



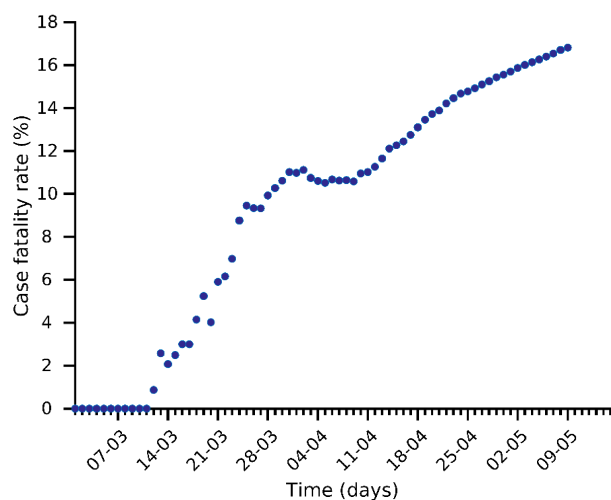
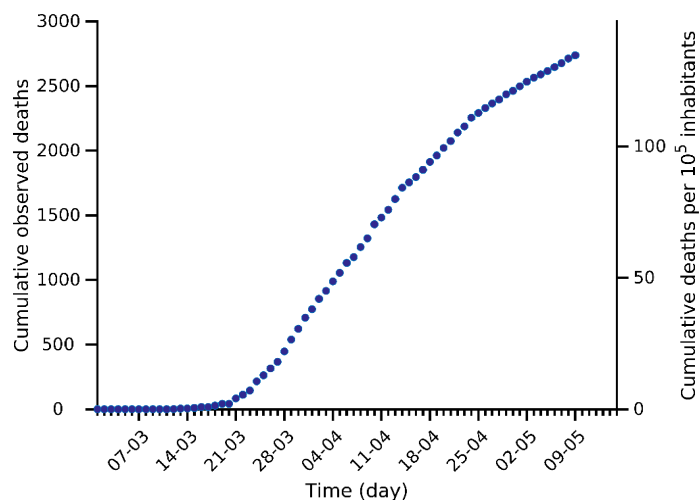
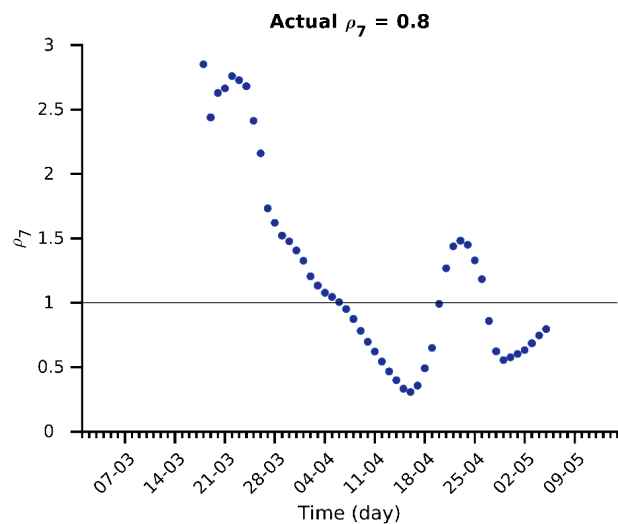
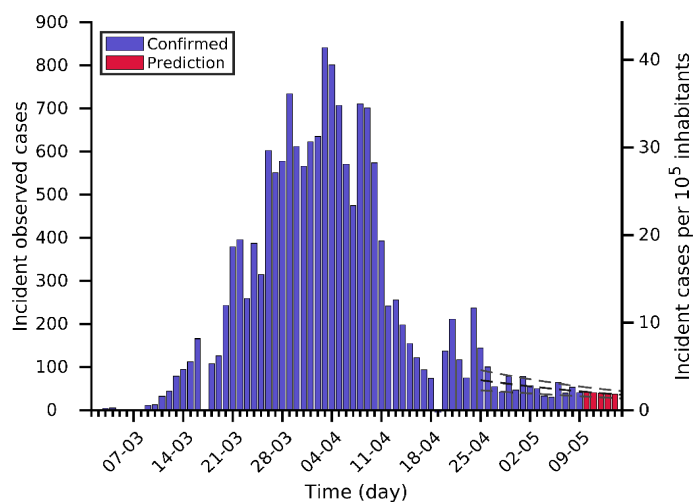
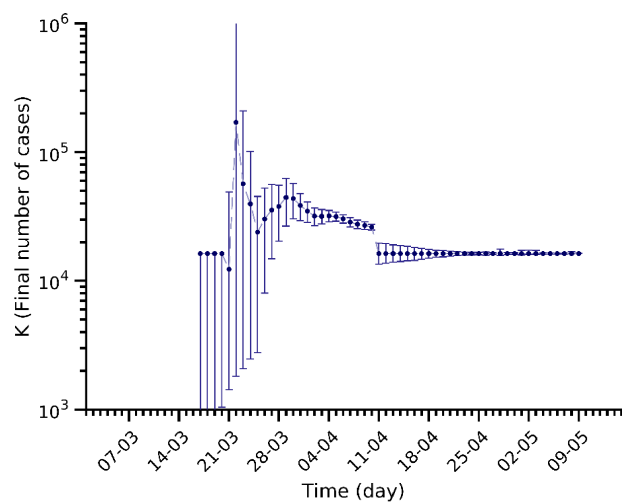
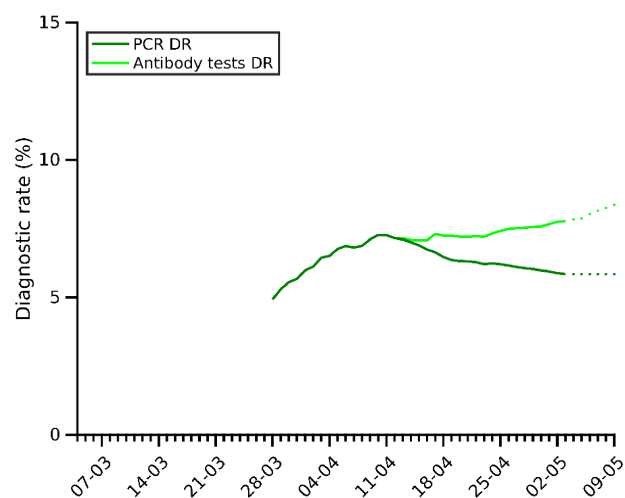
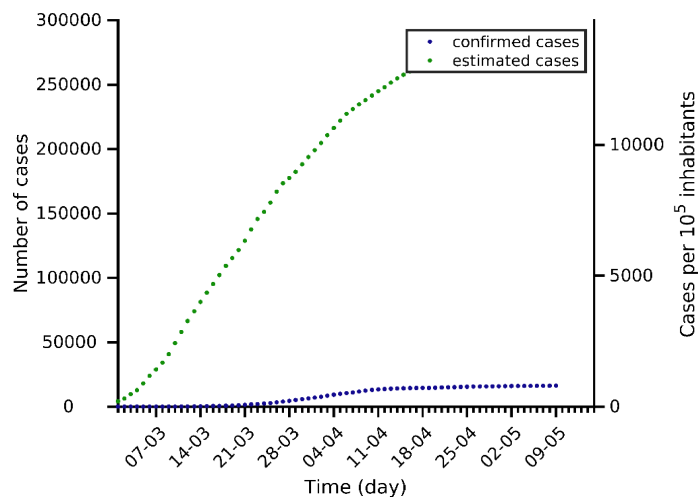
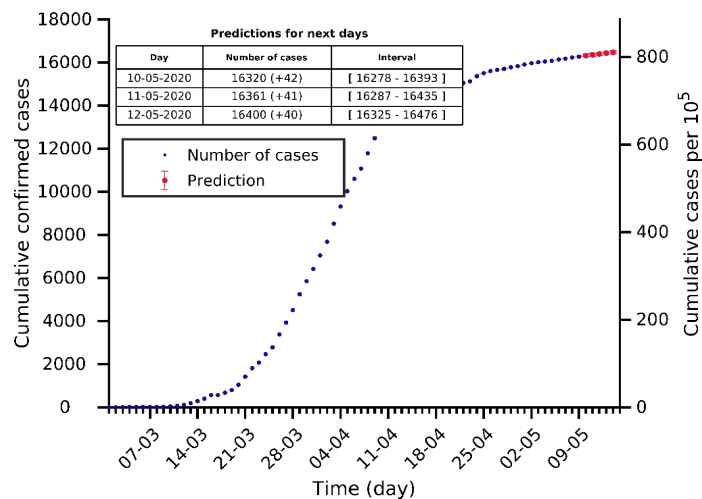
# Catalunya 09-05-2020. Population: 7.7M. Current cumulated incidence: 677/10<sup>5</sup>



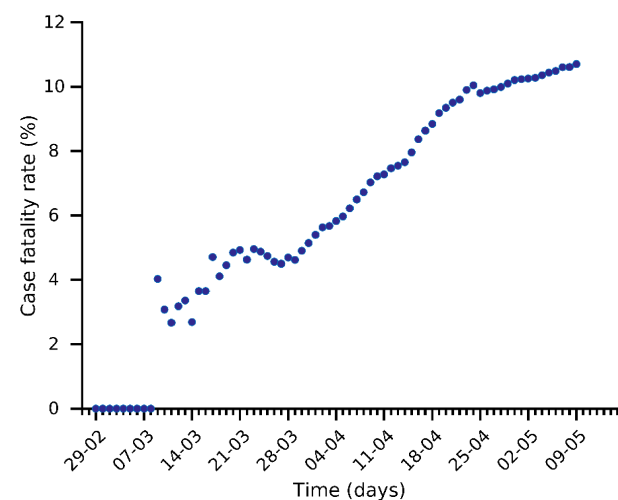
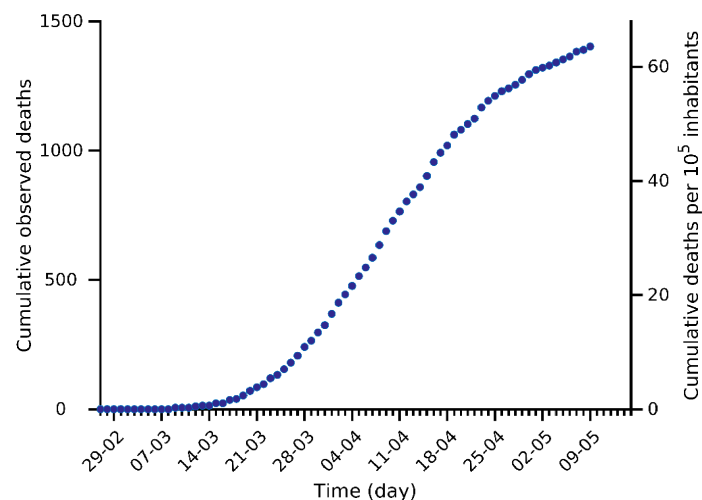
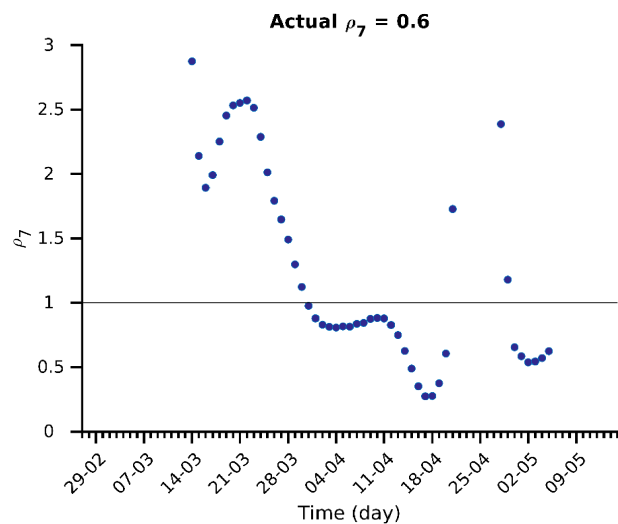
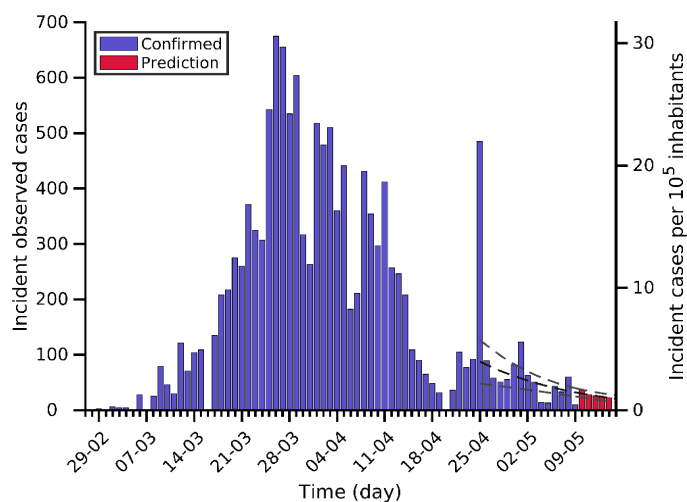
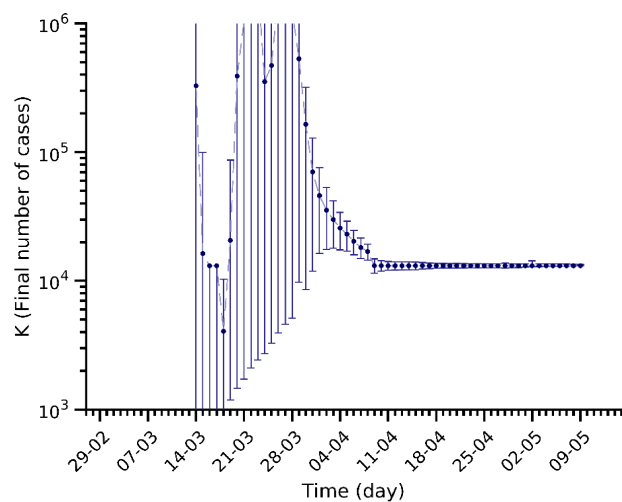
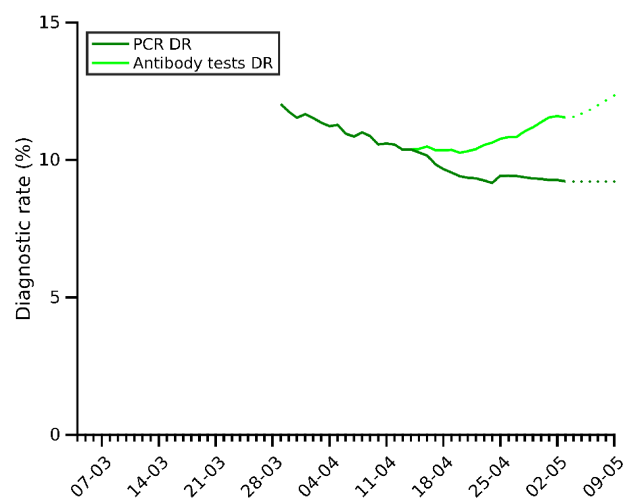
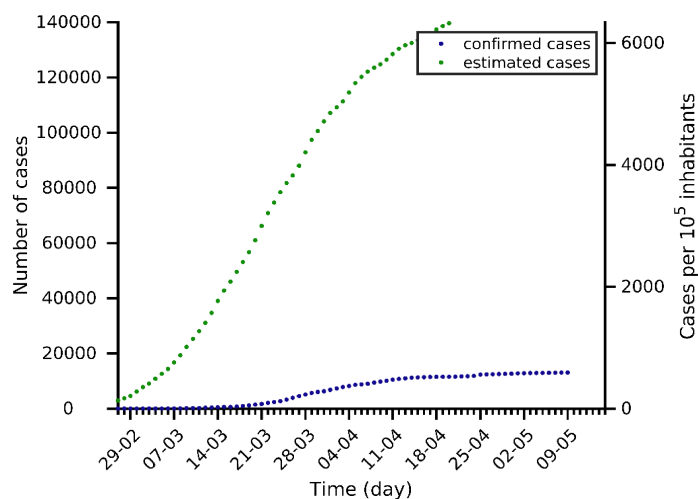
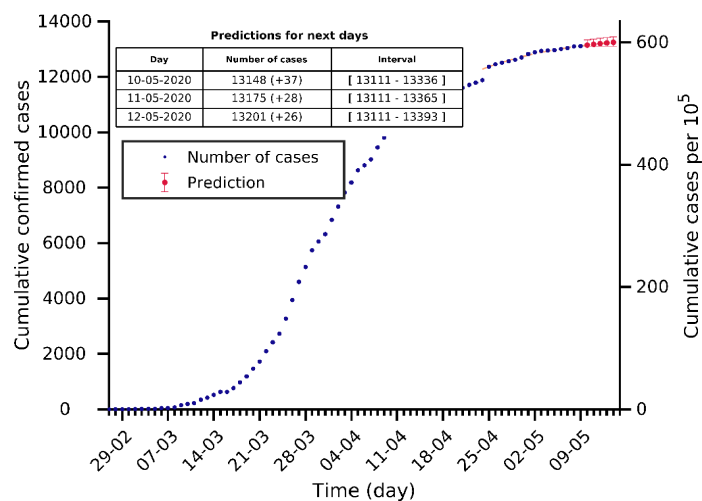
# Castilla Leon 09-05-2020. Population: 2.4M. Current cumulated incidence: 742/10<sup>5</sup>



# Castilla-La Mancha 09-05-2020. Population: 2.0M. Current cumulated incidence: 80

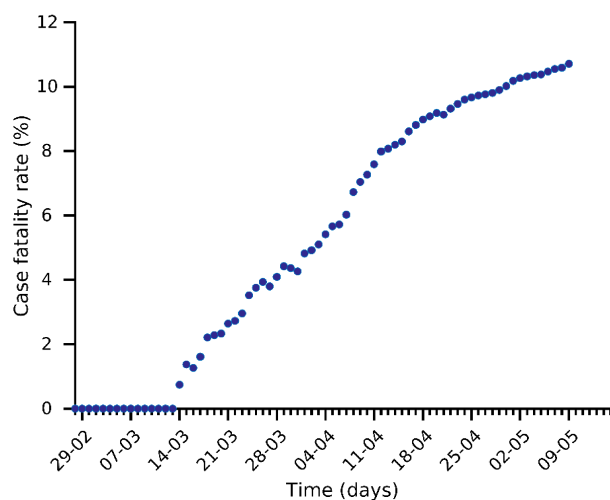
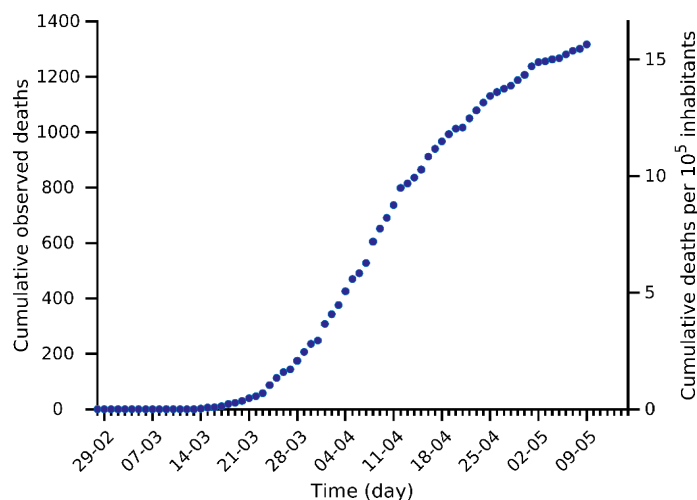
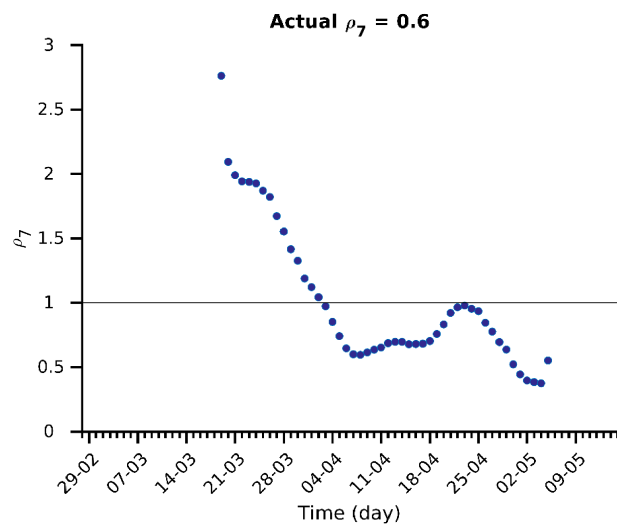
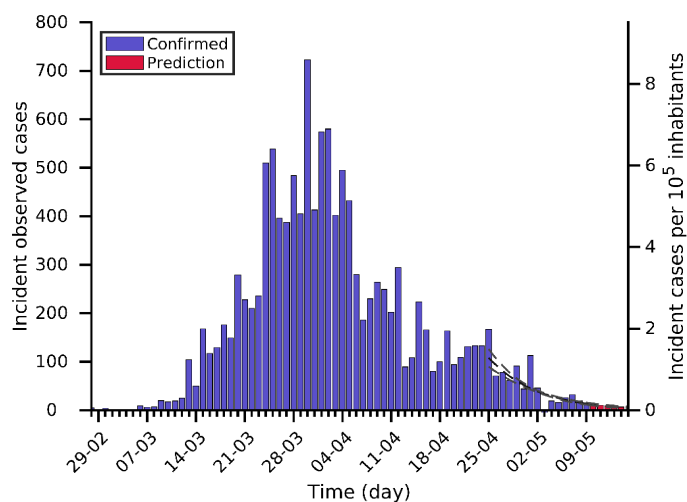
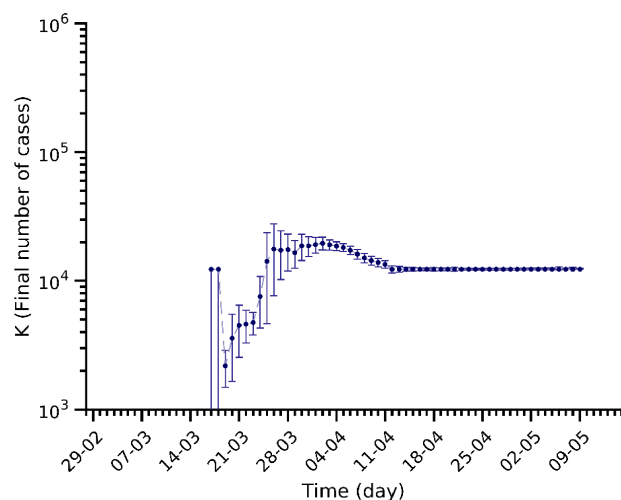
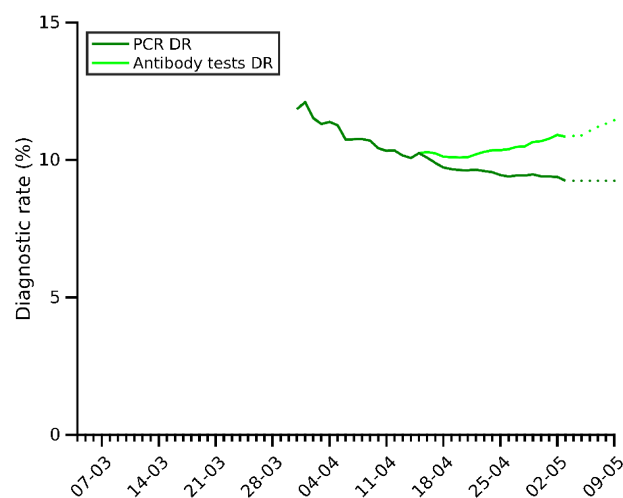
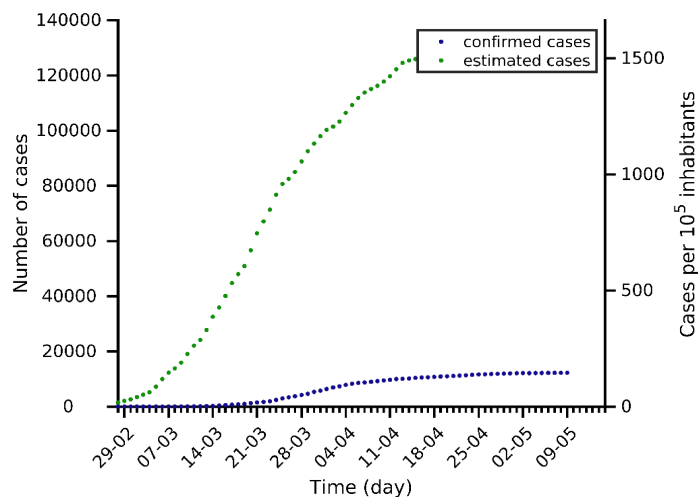
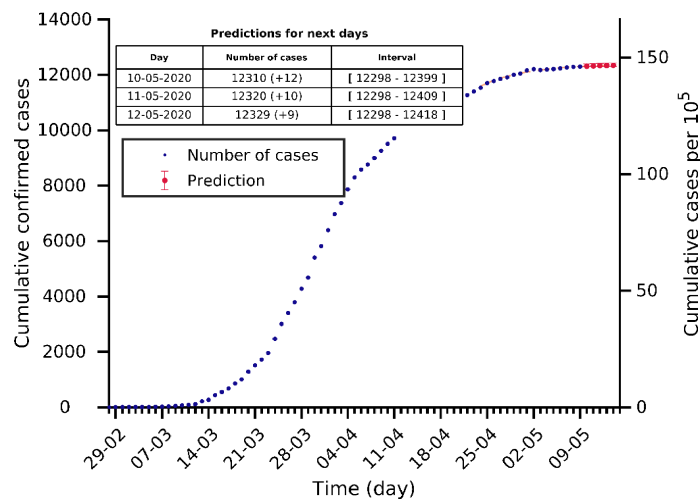


# Euskadi 09-05-2020. Population: 2.2M. Current cumulated incidence: 594/10<sup>5</sup>

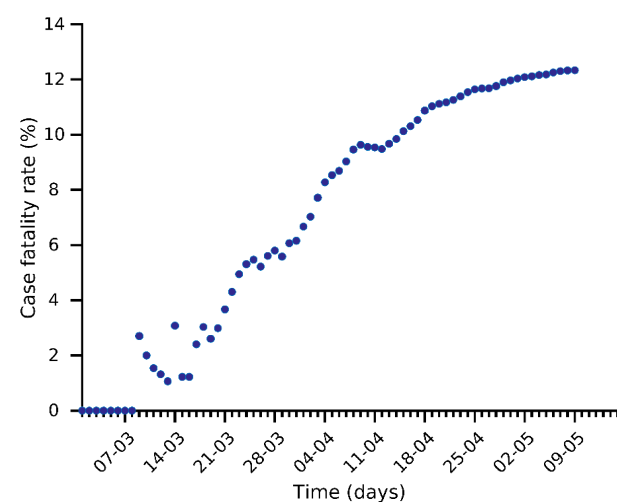
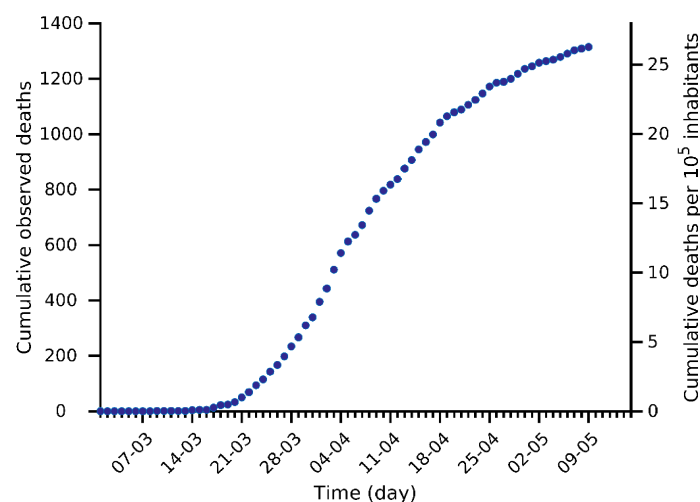
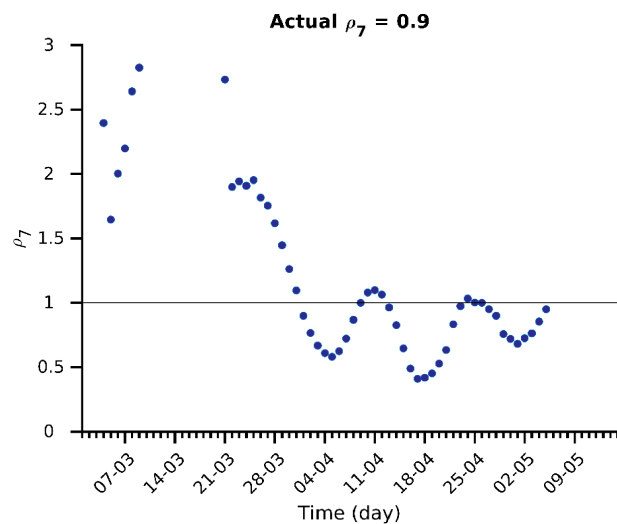
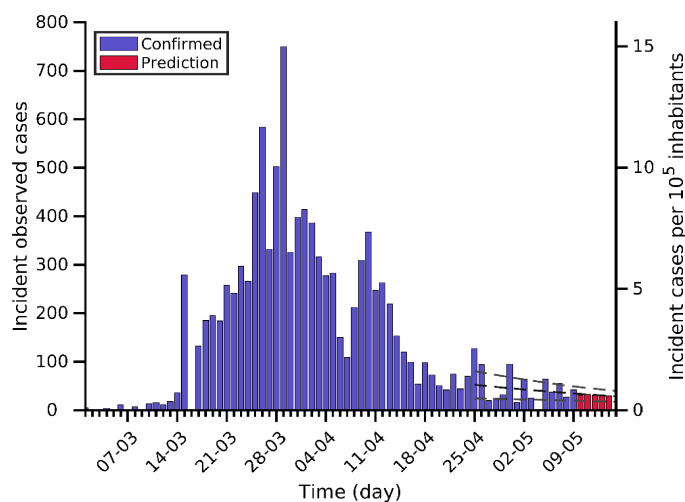
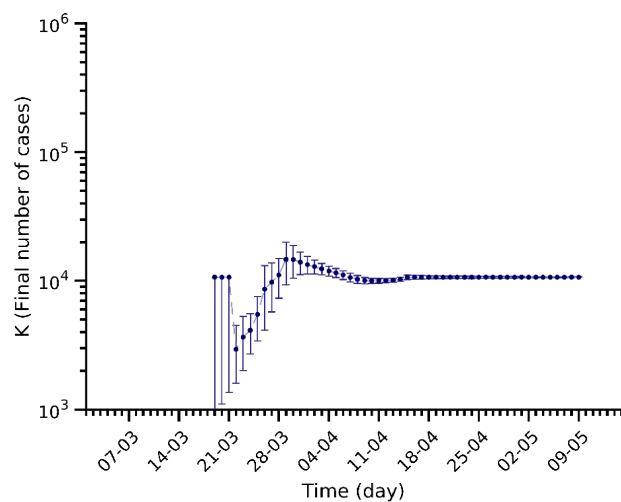
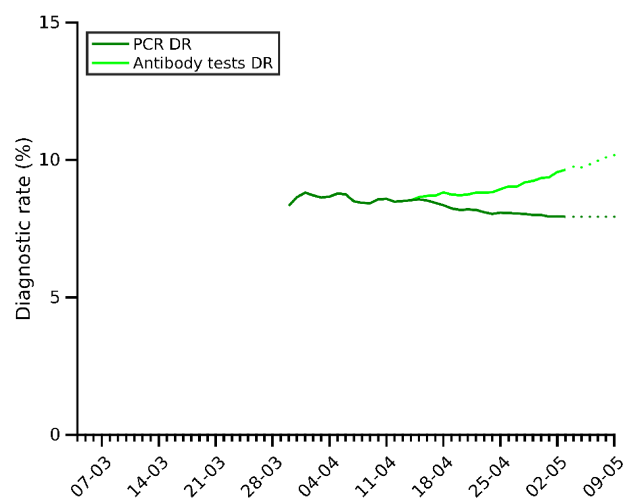
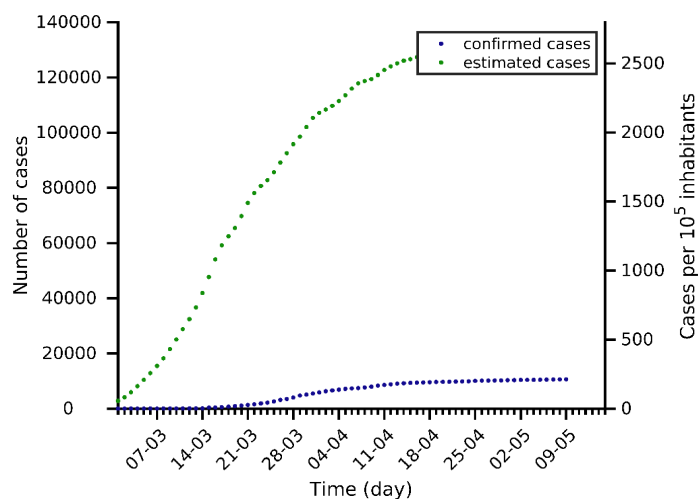
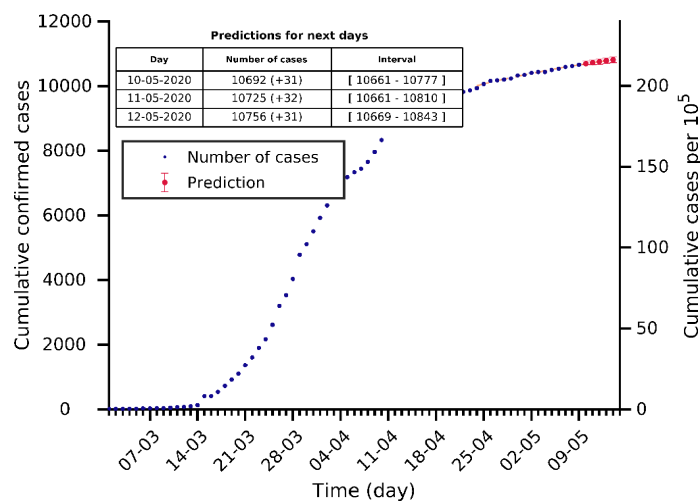




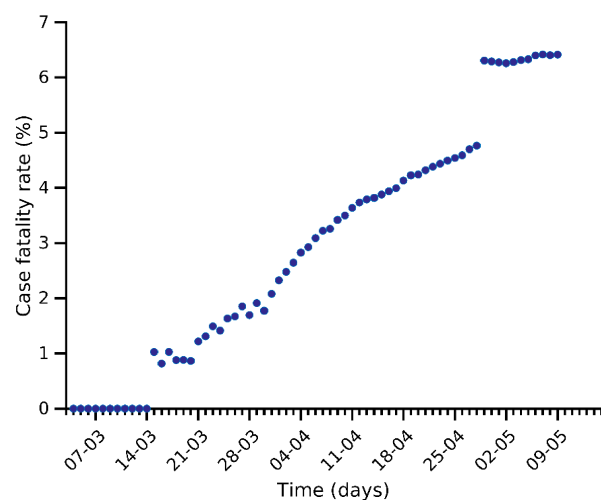
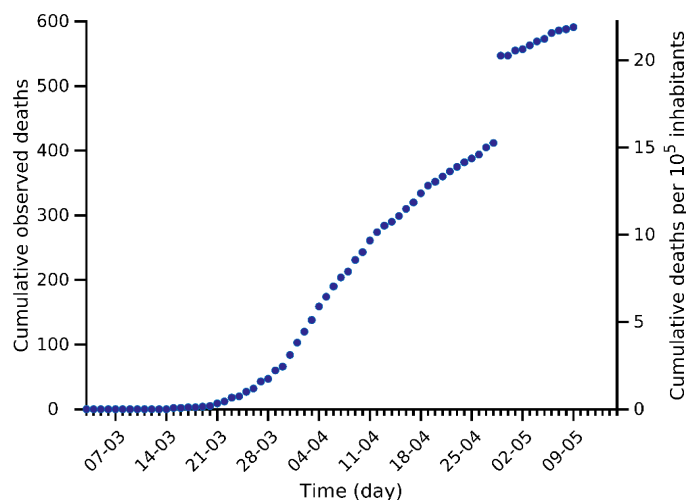
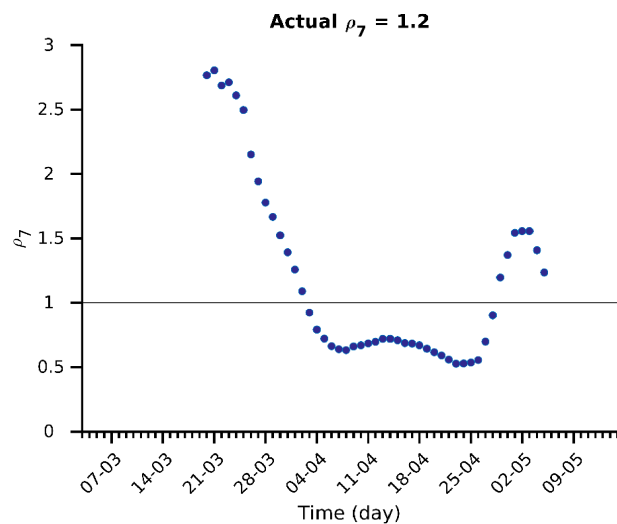
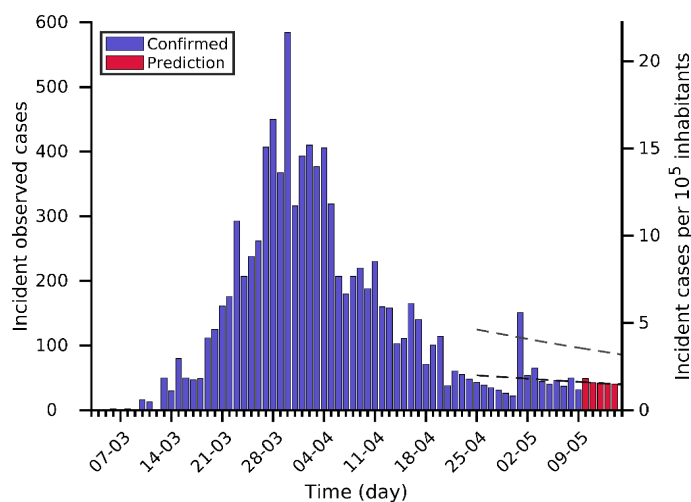
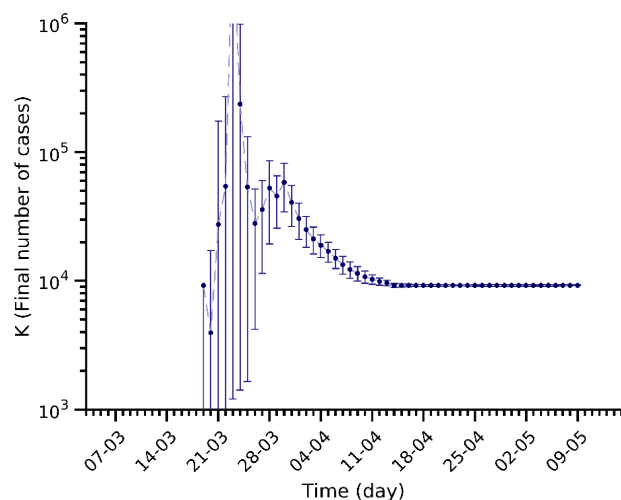
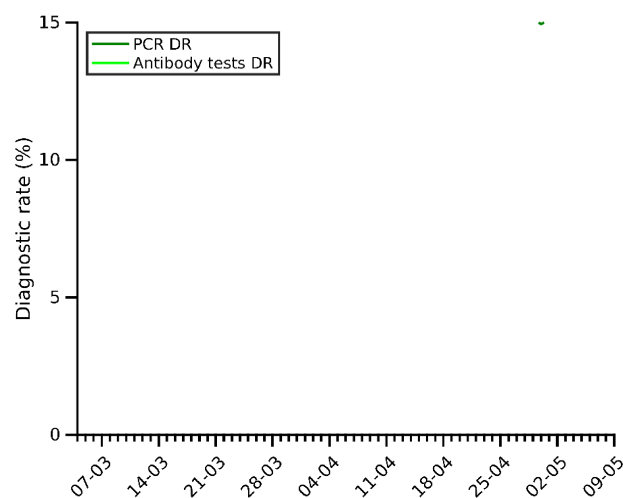
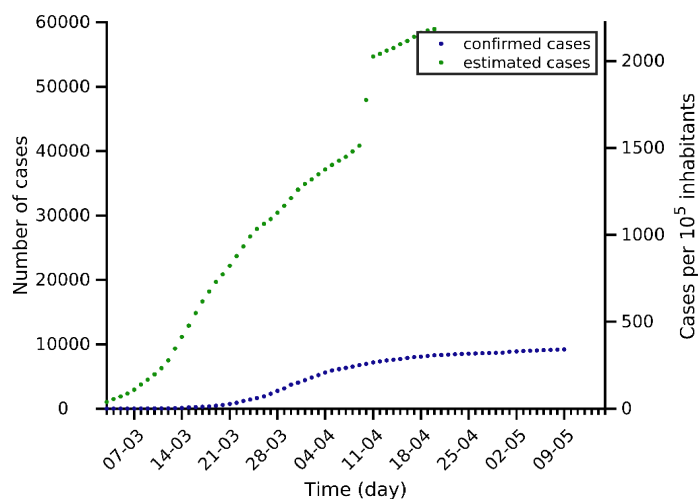
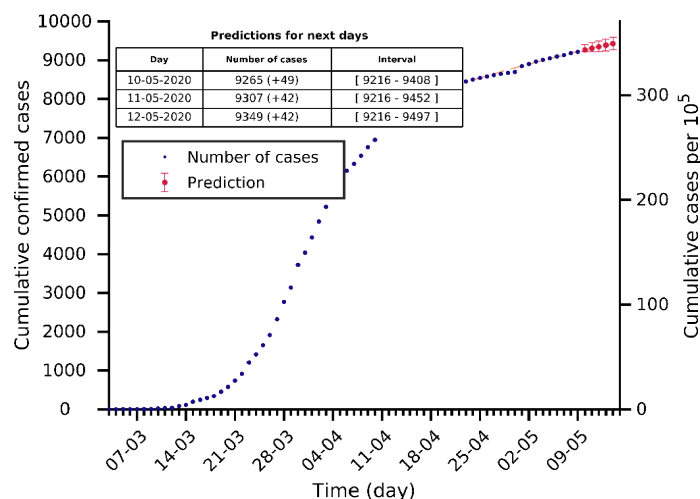
# Andalucia 09-05-2020. Population: 8.4M. Current cumulated incidence: 146/10<sup>5</sup>



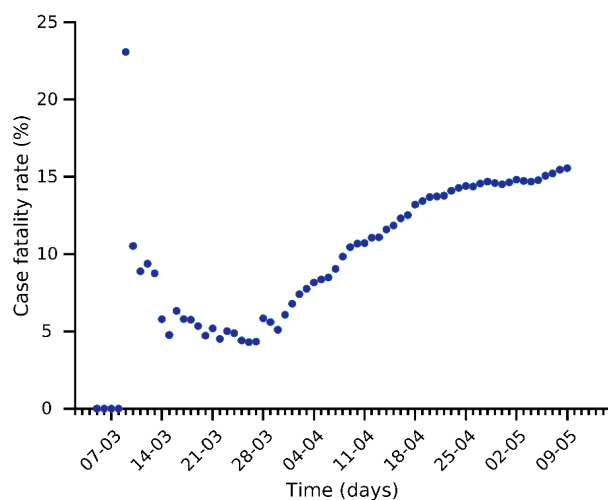
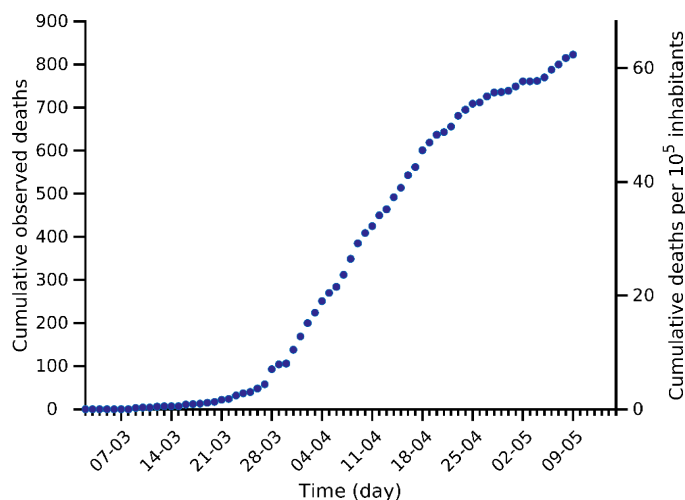
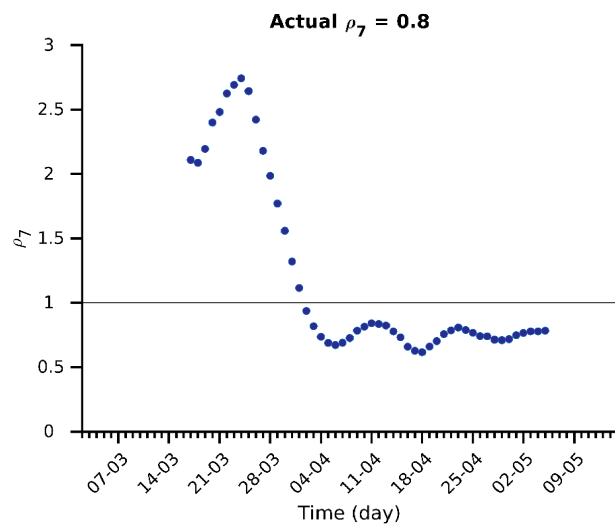
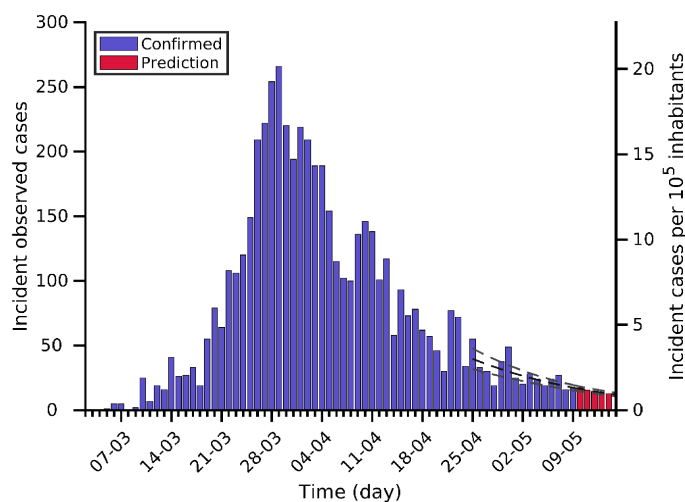
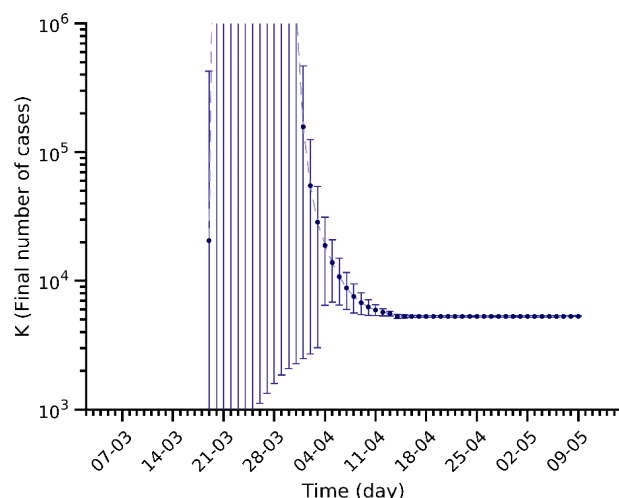
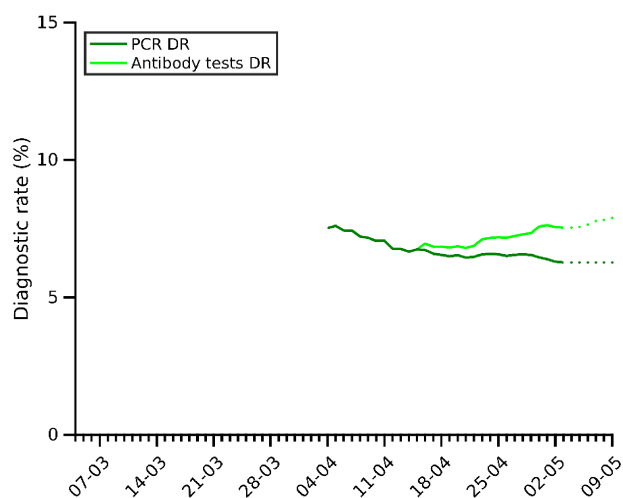
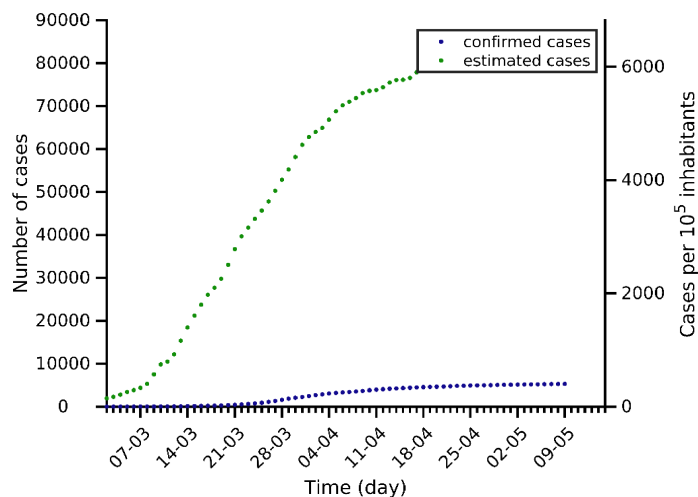
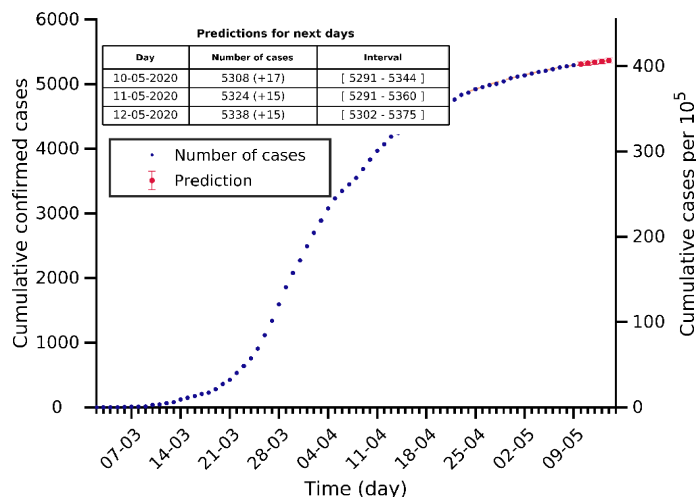
# C Valenciana 09-05-2020. Population: 5.0M. Current cumulated incidence: 213/10<sup>5</sup>



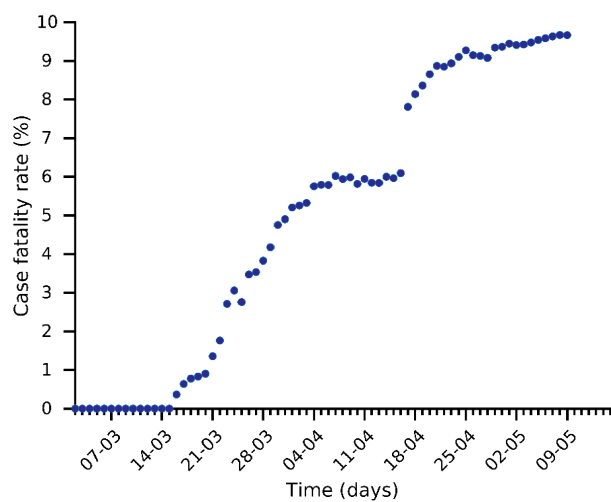
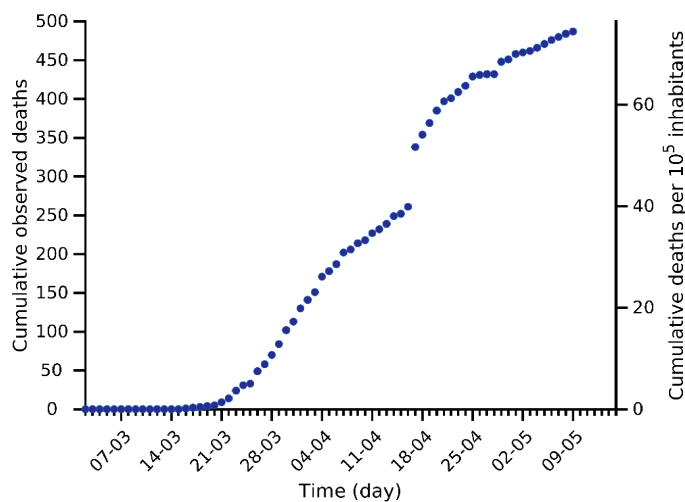
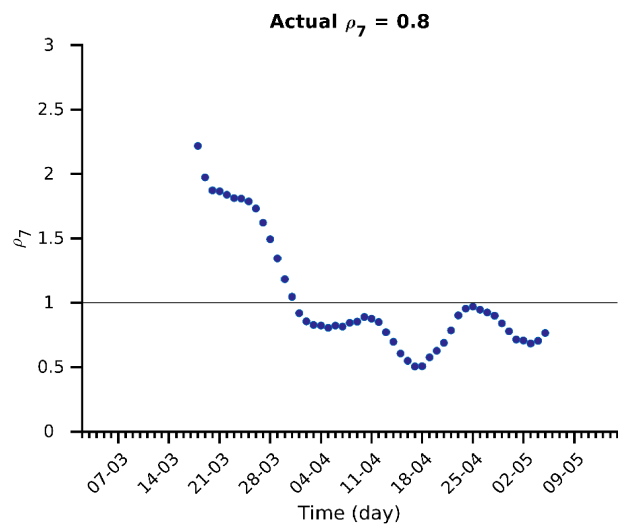
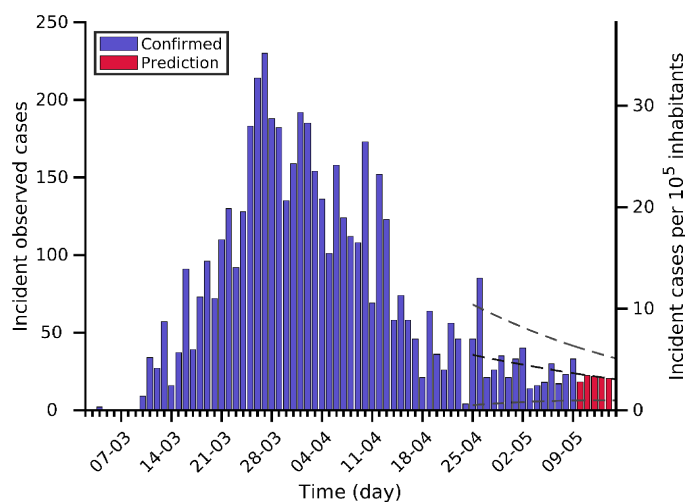
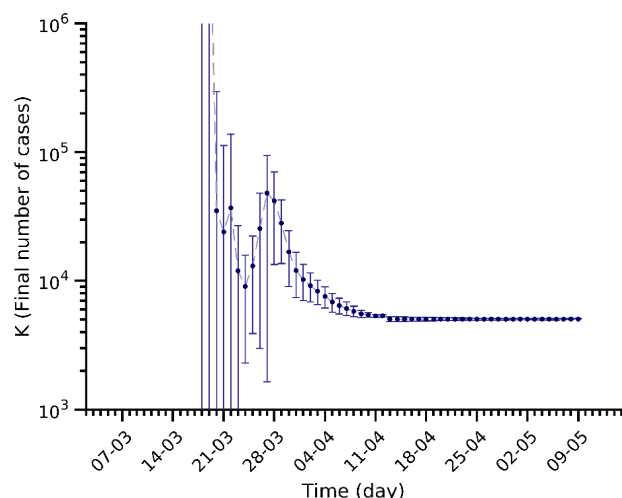
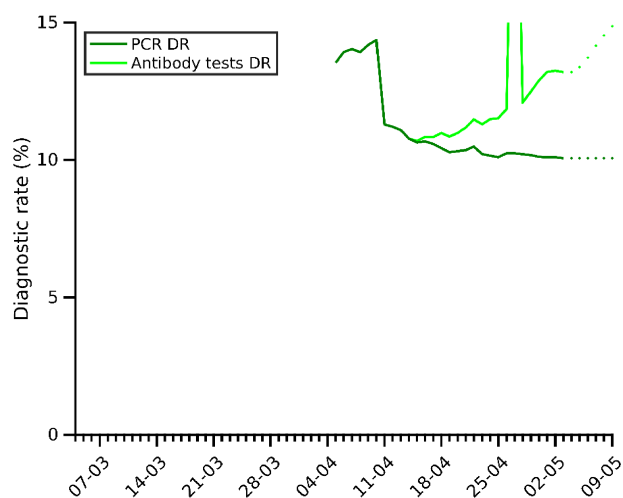
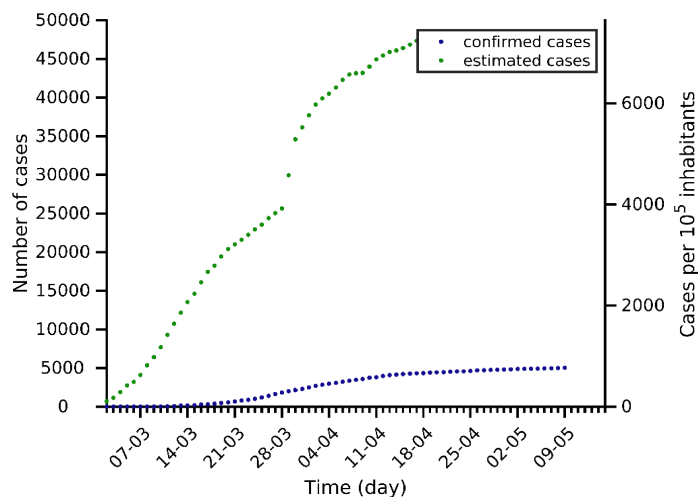
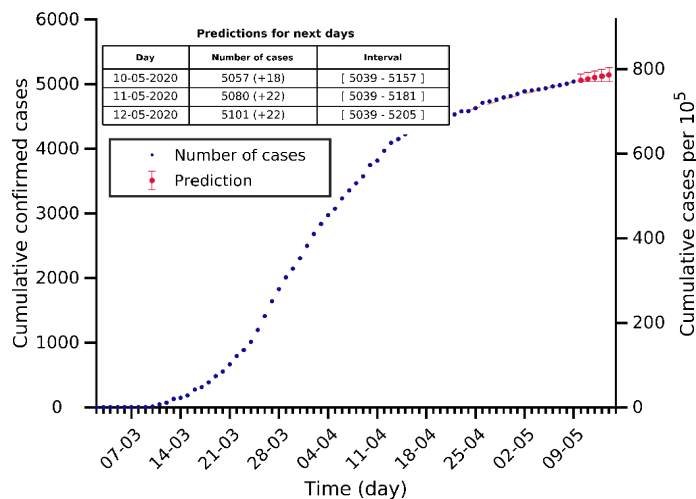
# Galicia 09-05-2020. Population: 2.7M. Current cumulated incidence: 341/10<sup>5</sup>



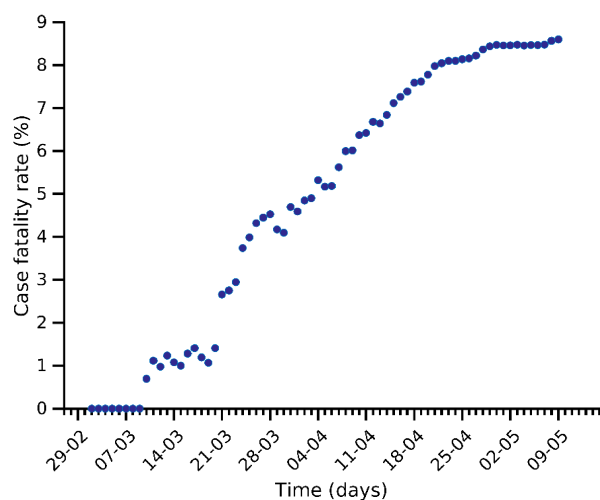
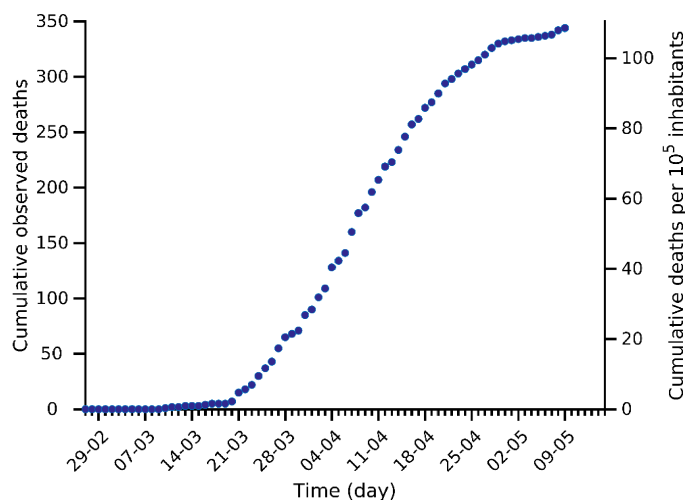
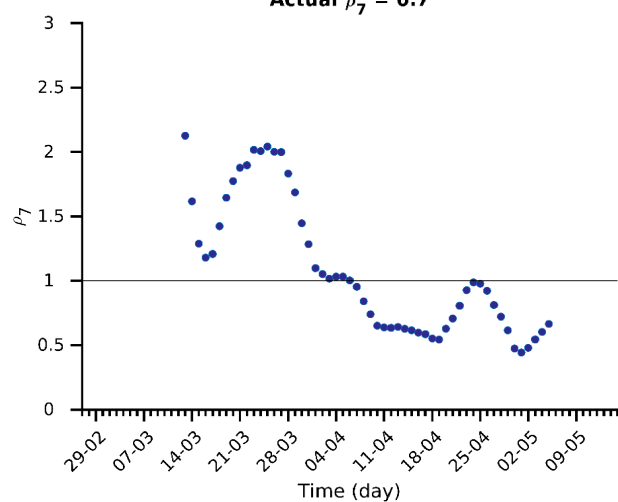
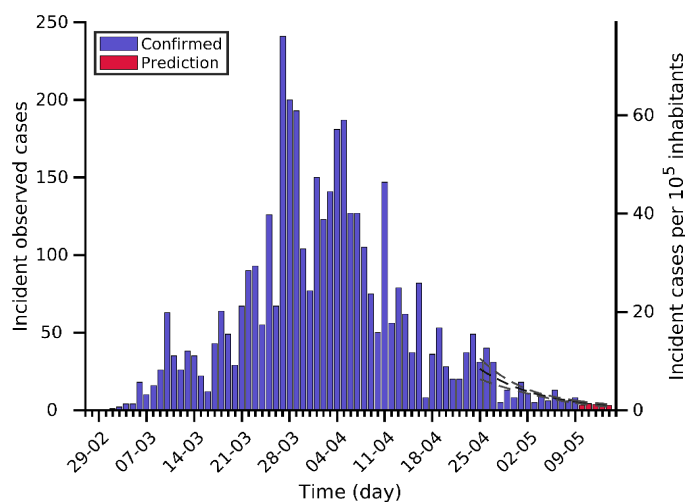
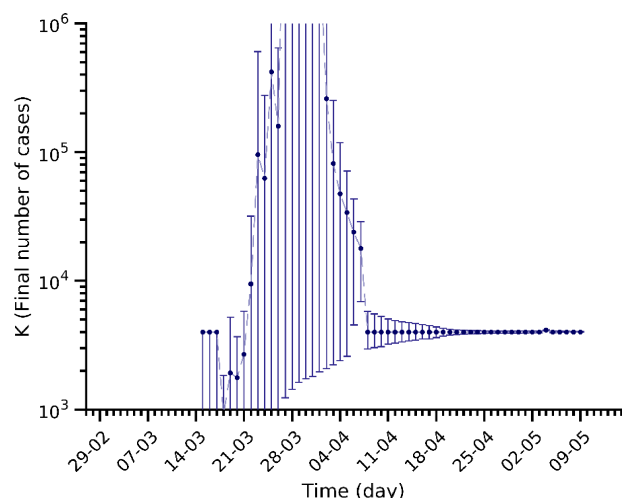
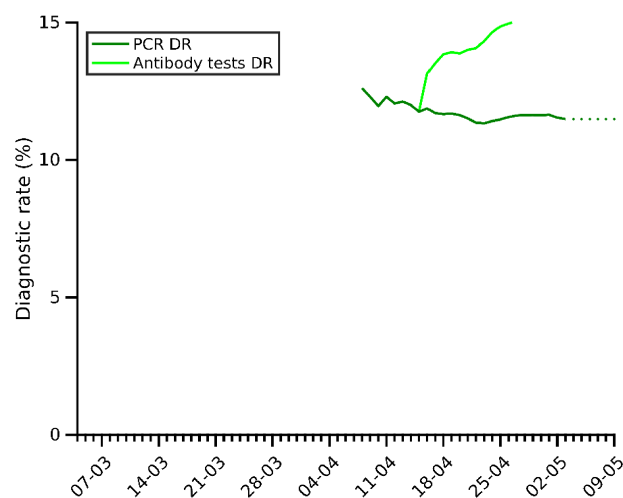
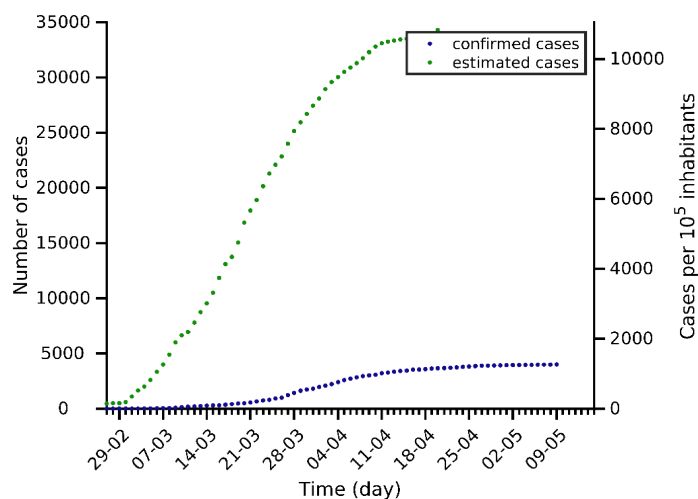
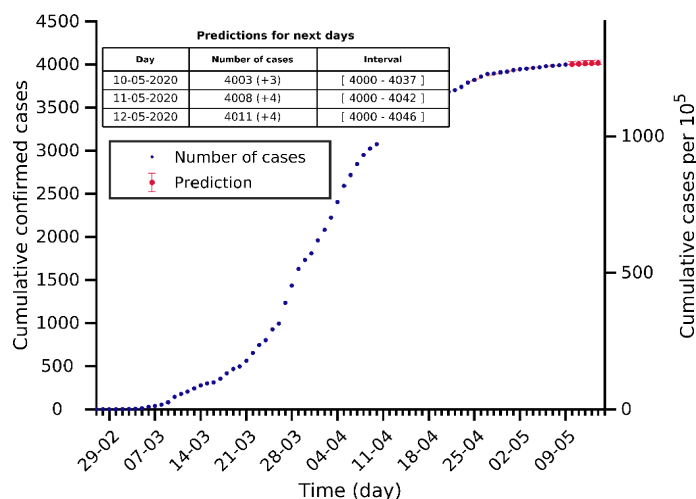
# Aragon 09-05-2020. Population: 1.3M. Current cumulated incidence: 401/10<sup>5</sup>



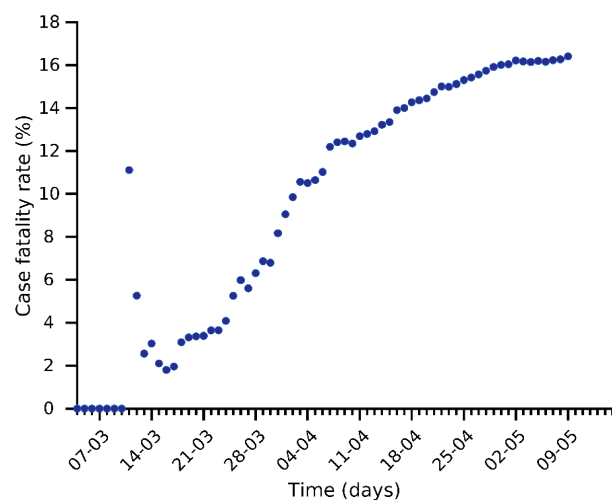
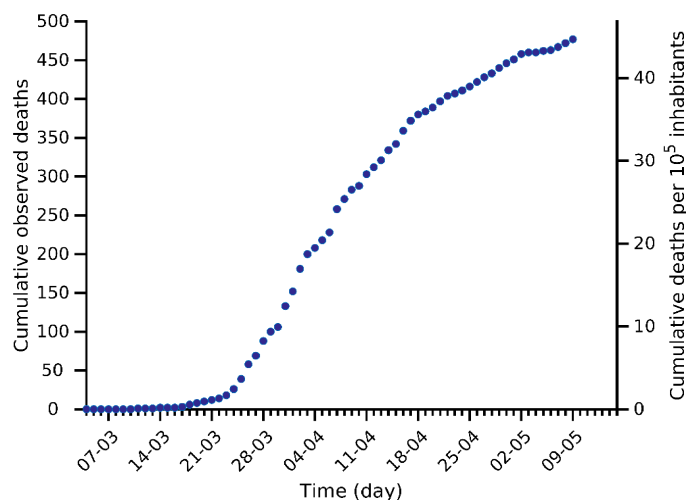
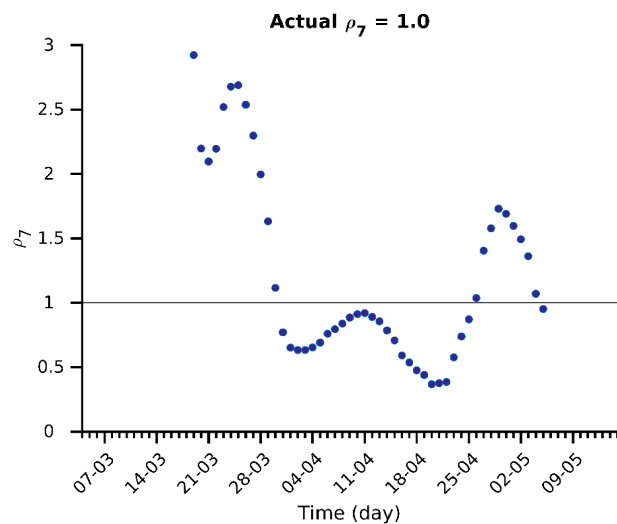
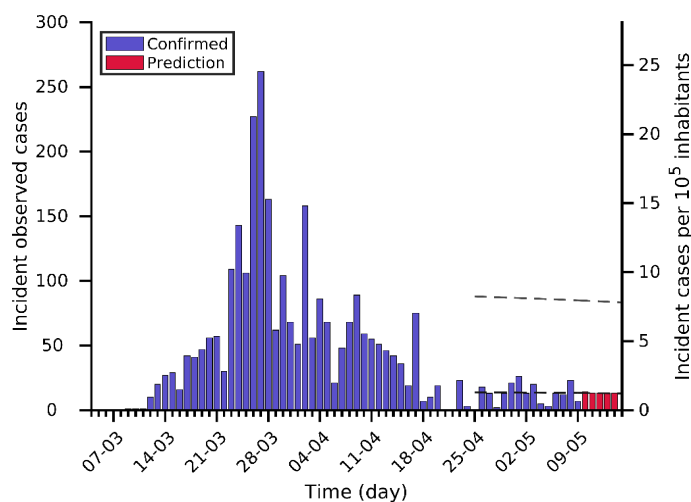
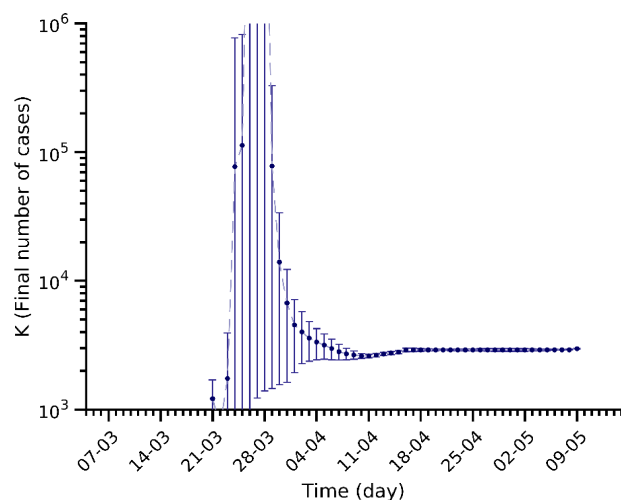
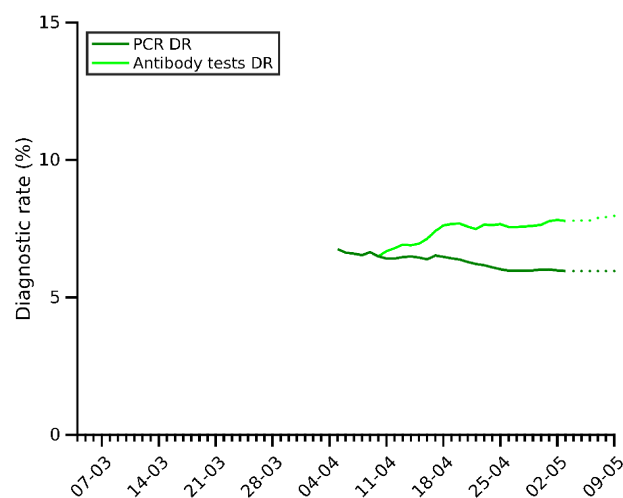
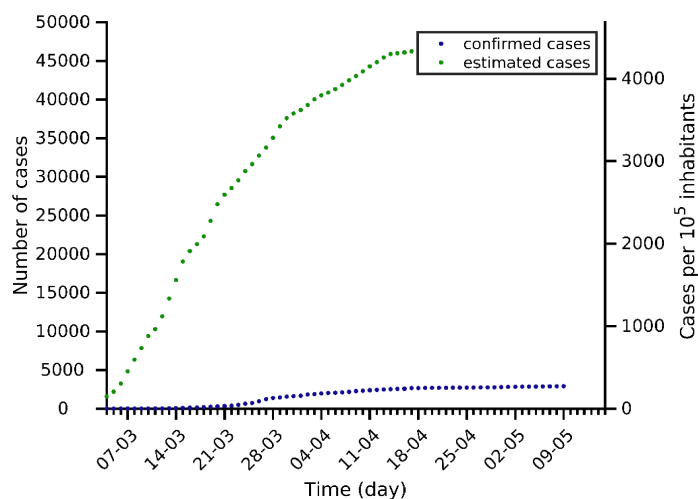
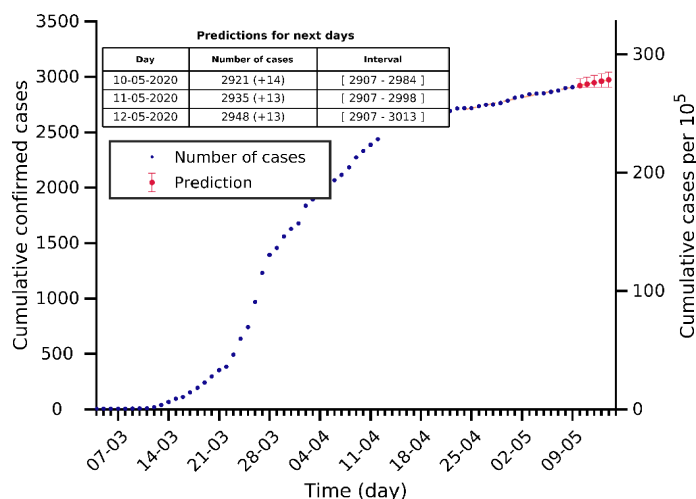
# Navarra 09-05-2020. Population: 0.7M. Current cumulated incidence: 770/10<sup>5</sup>



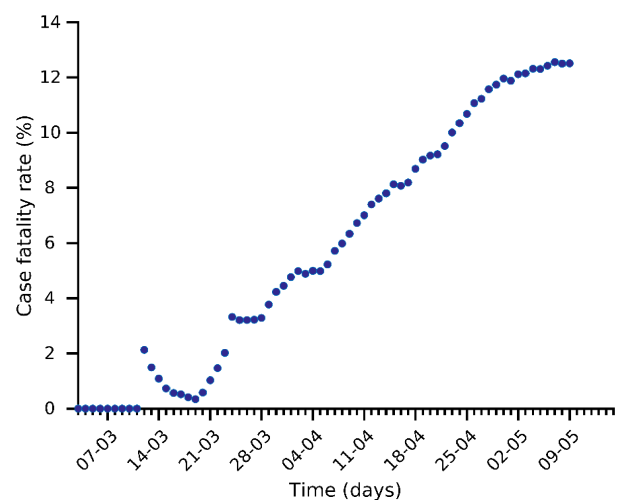
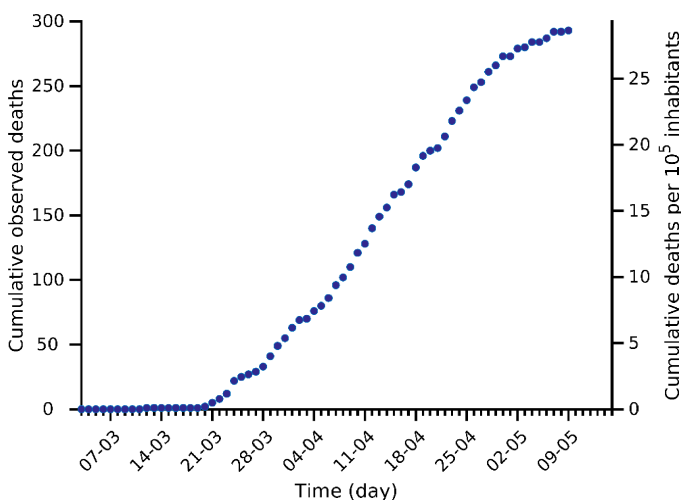
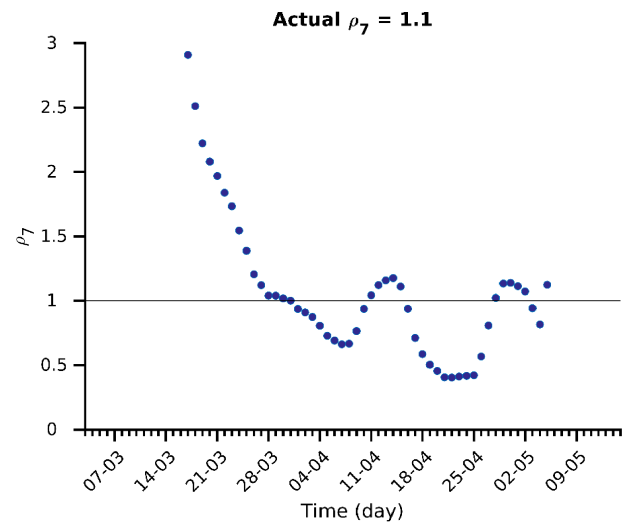
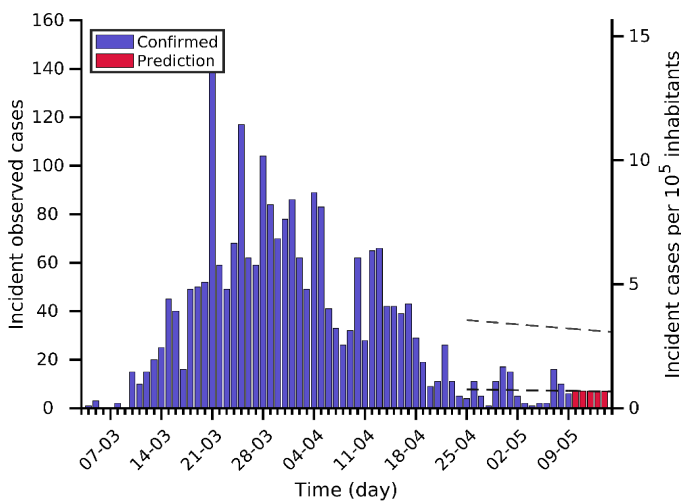
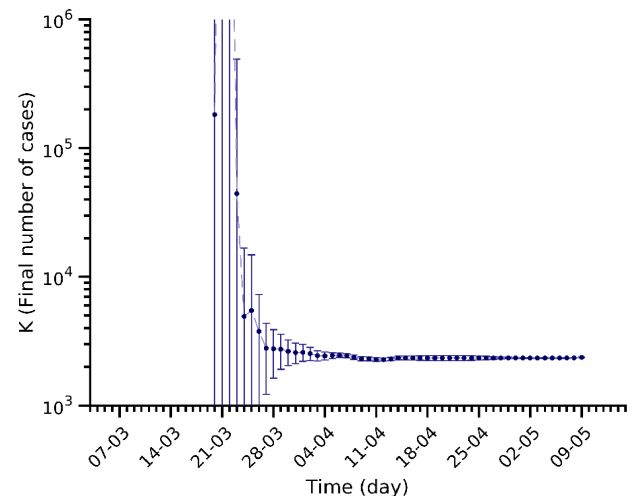
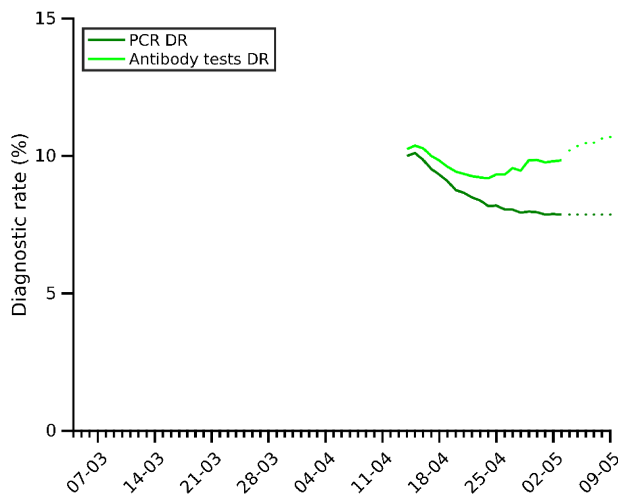
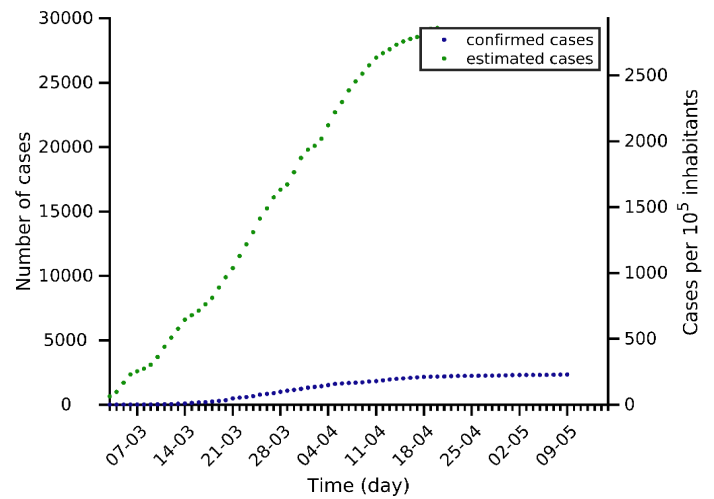
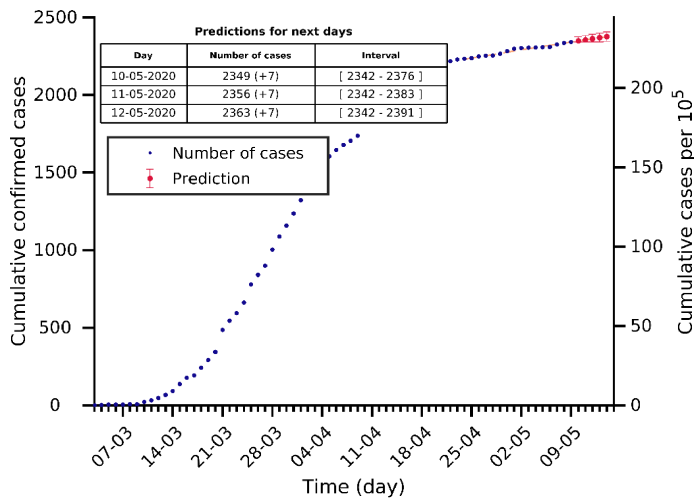
# La Rioja 09-05-2020. Population: 0.3M. Current cumulated incidence: 1263/10<sup>5</sup>



# Extremadura 09-05-2020. Population: 1.1M. Current cumulated incidence: 272/10<sup>5</sup>

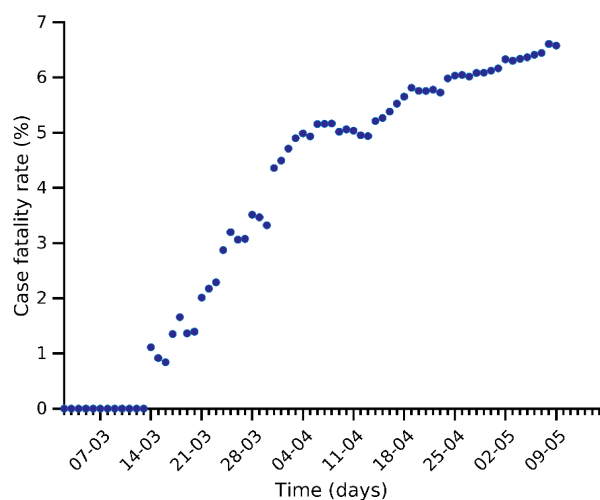
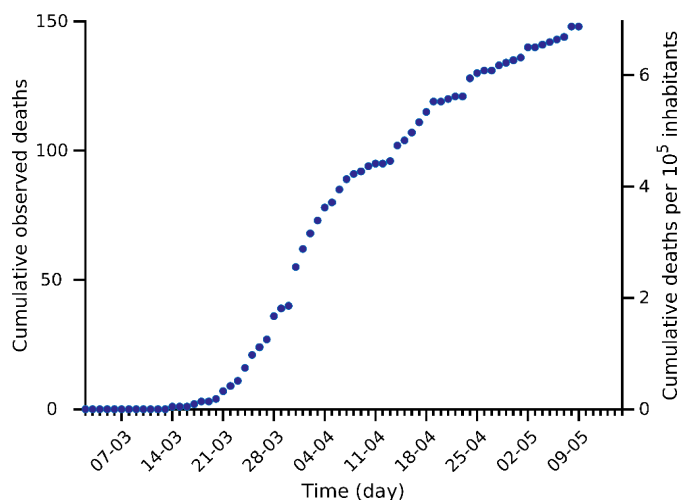
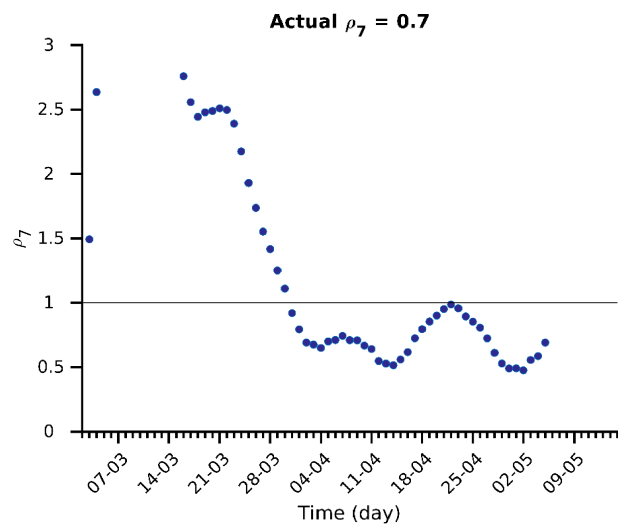
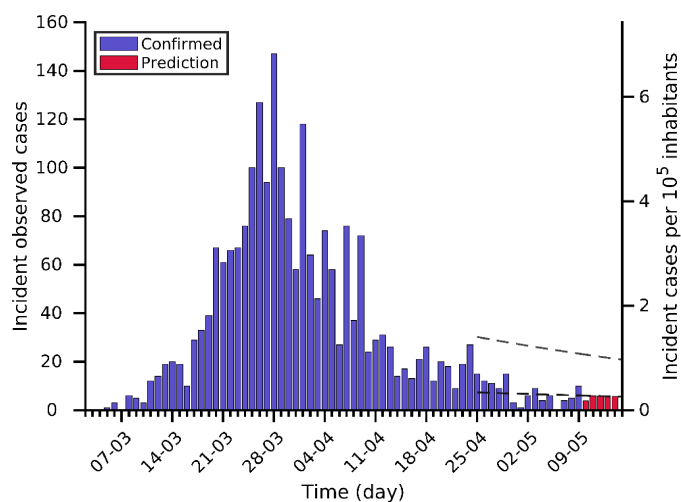
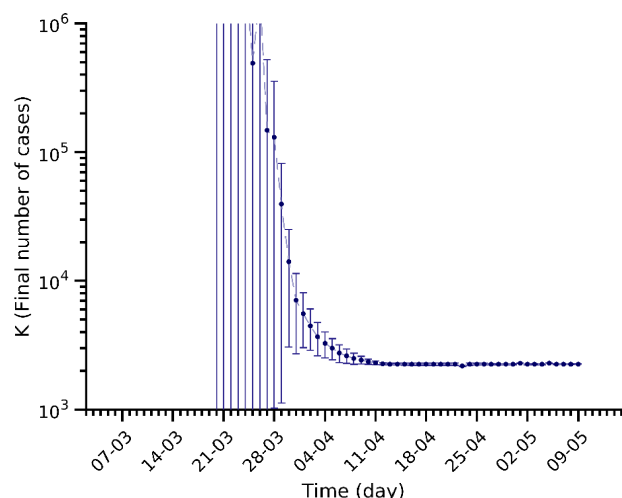
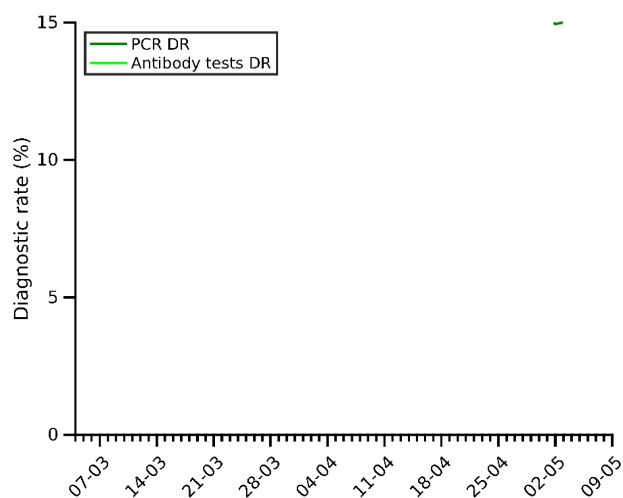
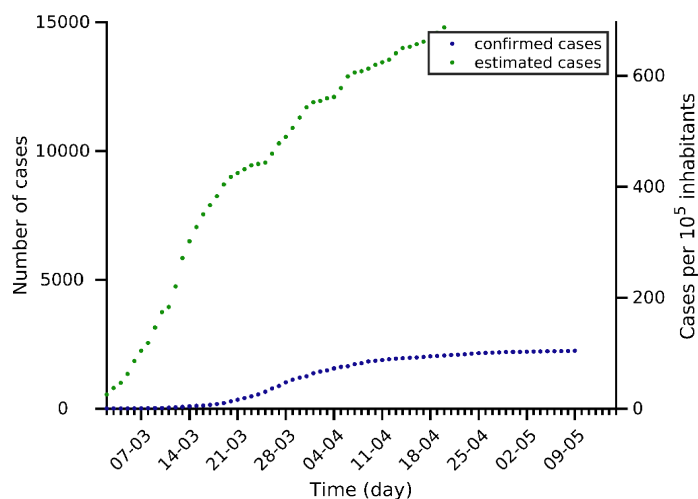
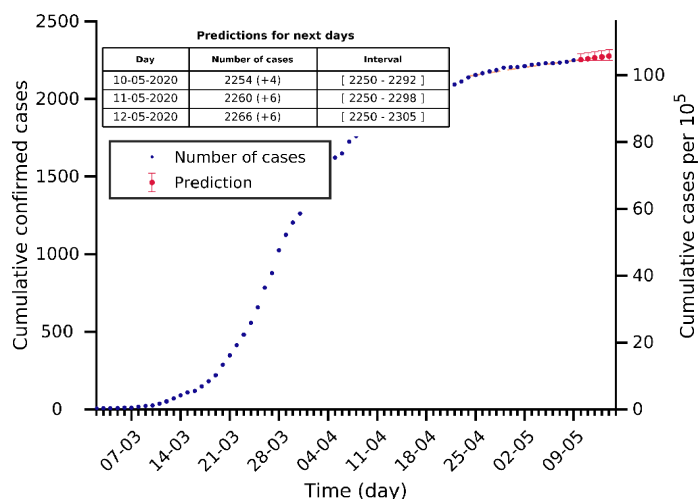


# Asturias 09-05-2020. Population: 1.0M. Current cumulated incidence: 229/10<sup>5</sup>

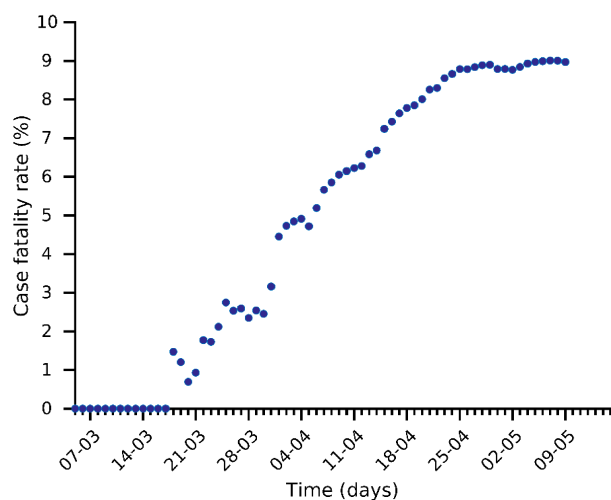
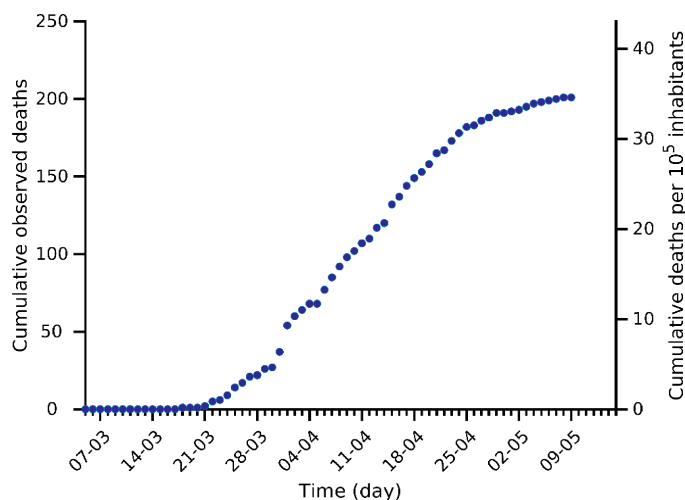
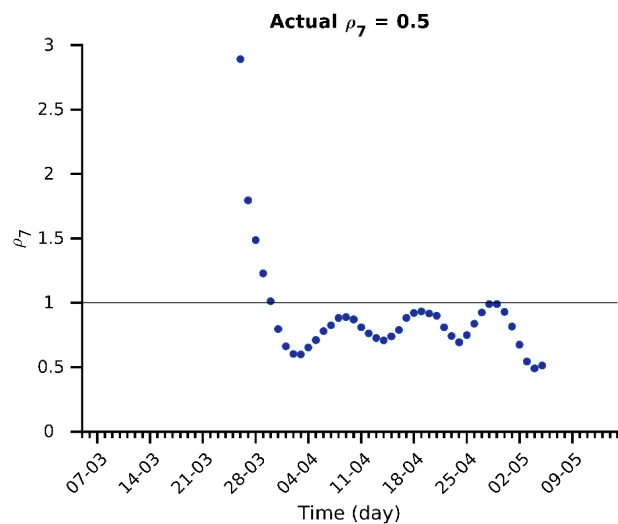
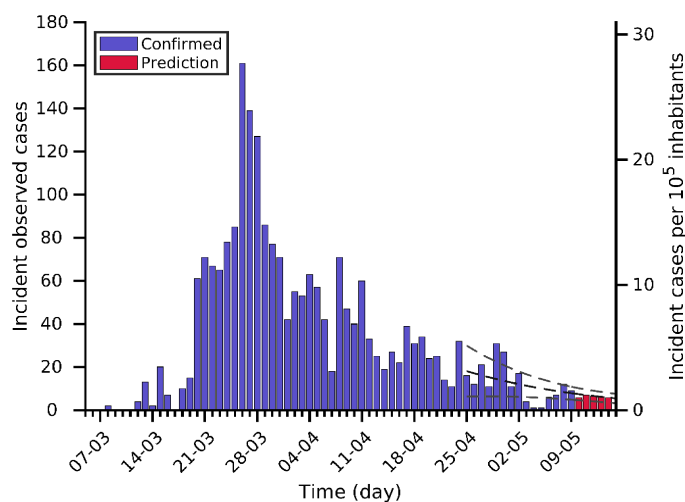
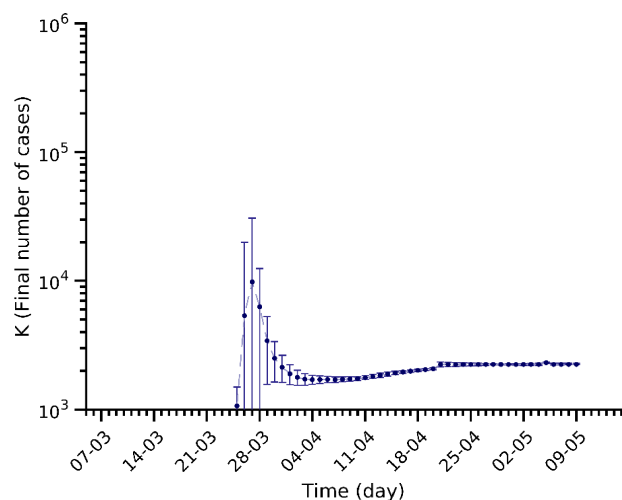
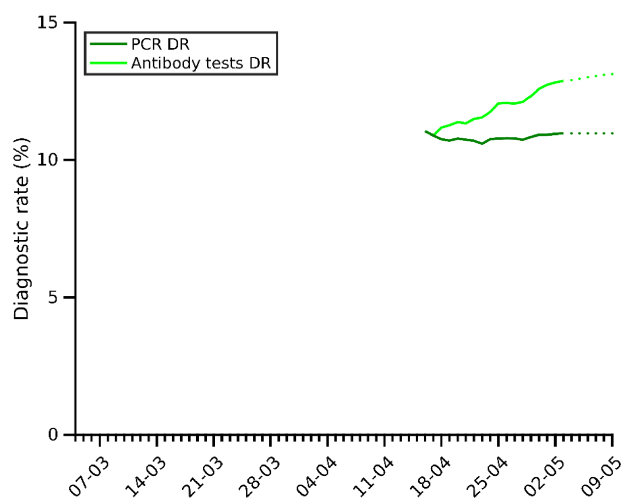
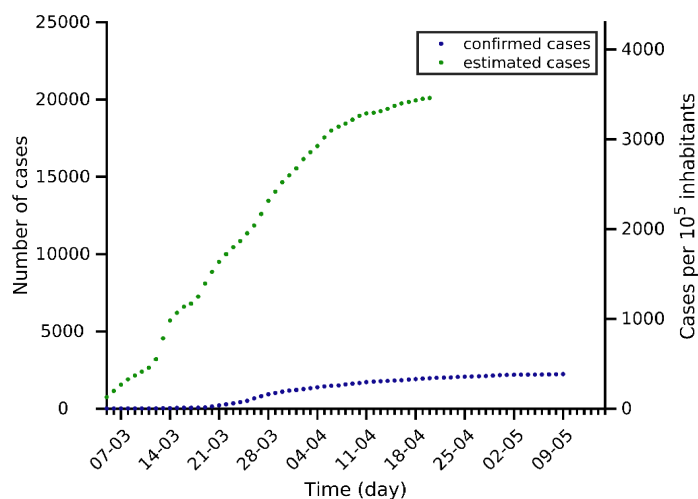
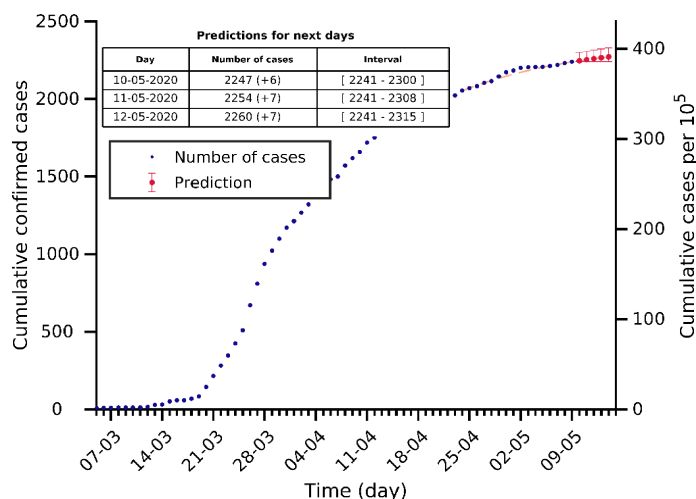




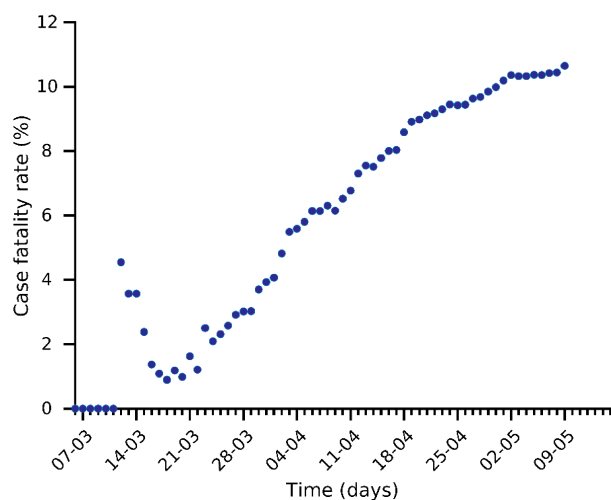
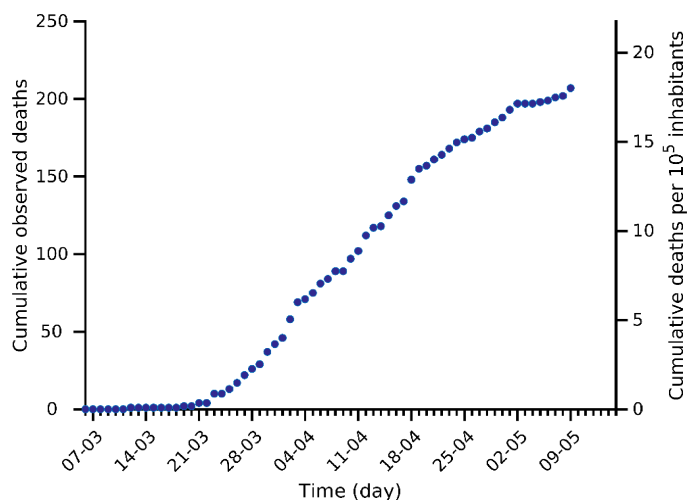
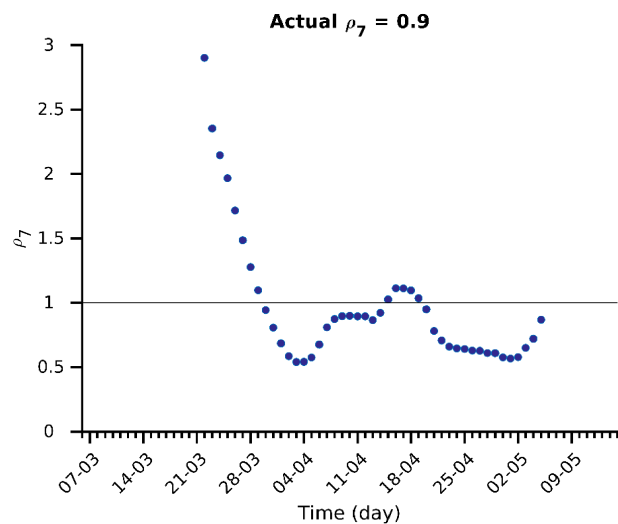
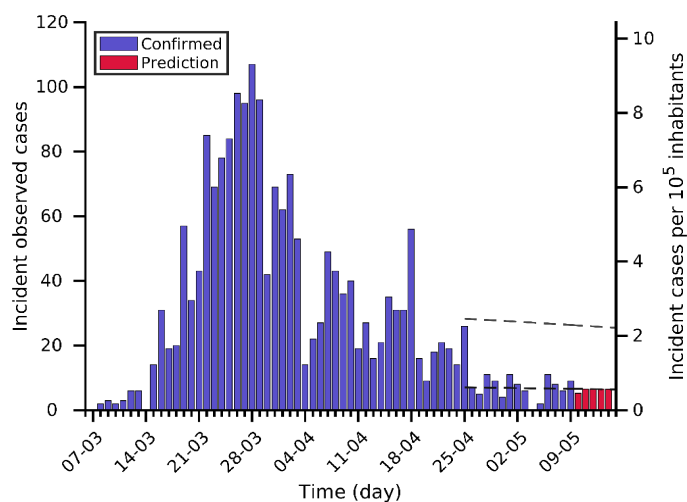
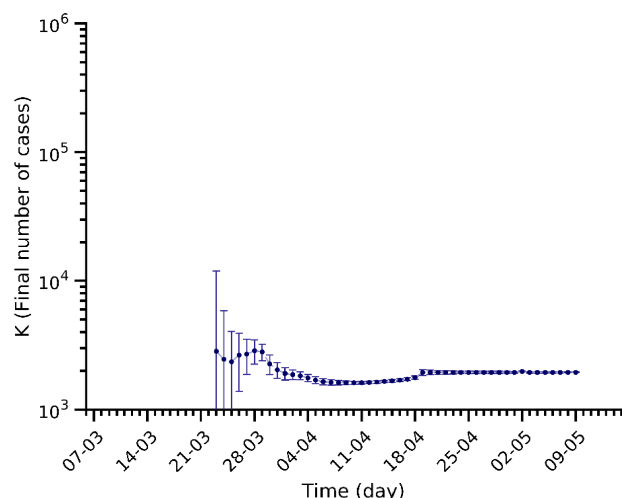
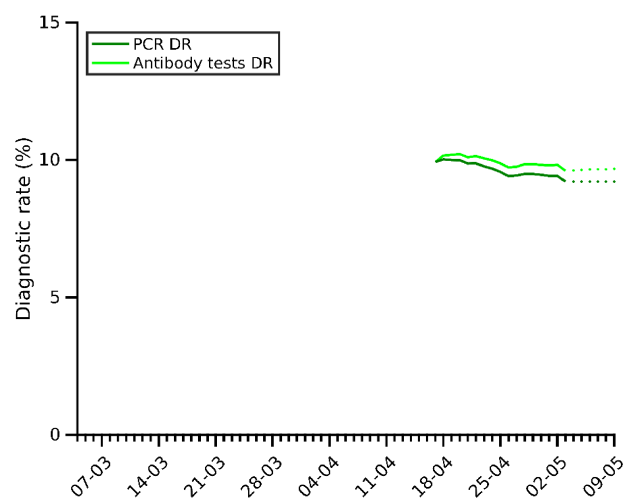
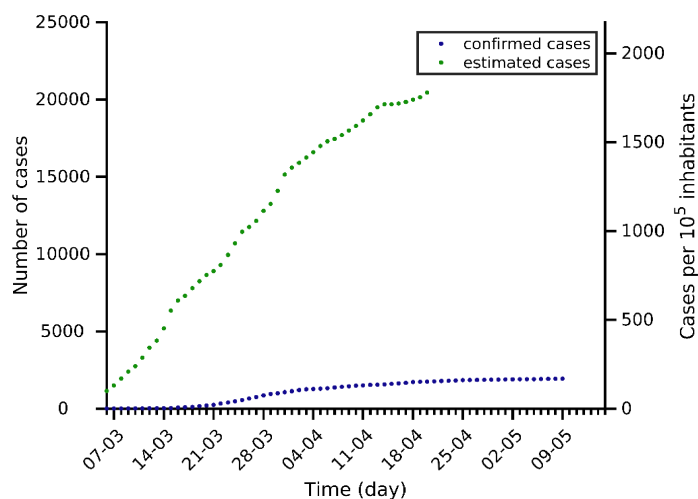
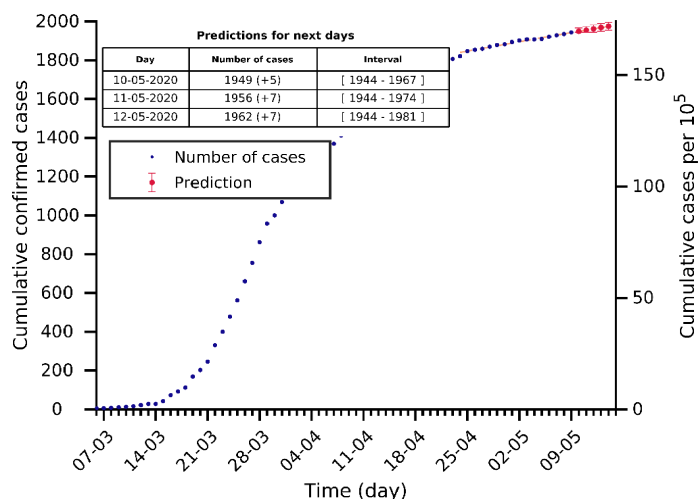
# Canarias 09-05-2020. Population: 2.2M. Current cumulated incidence: 104/10<sup>5</sup>



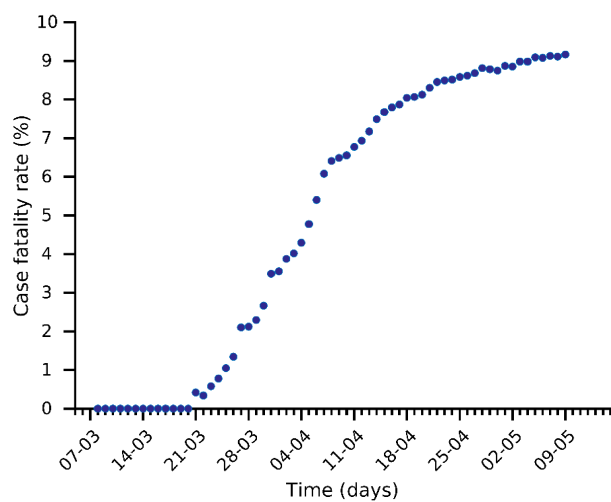
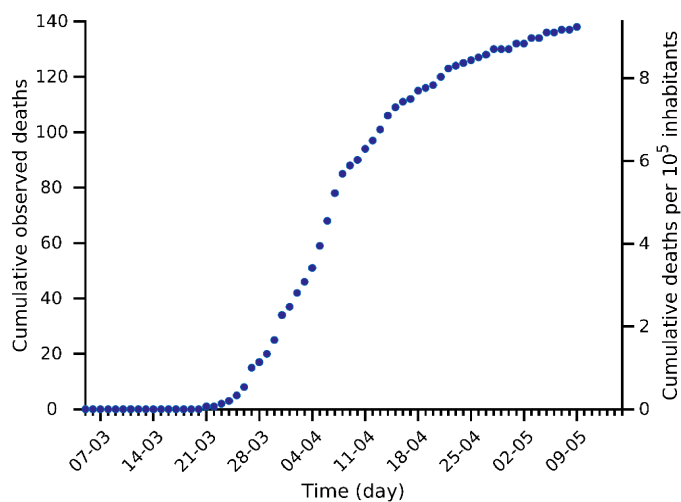
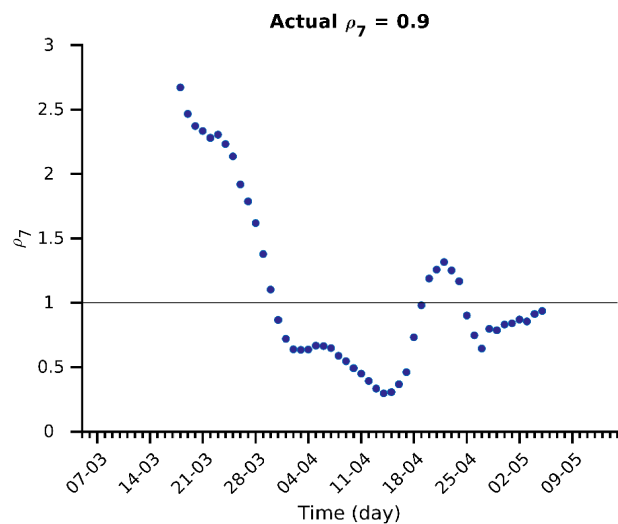
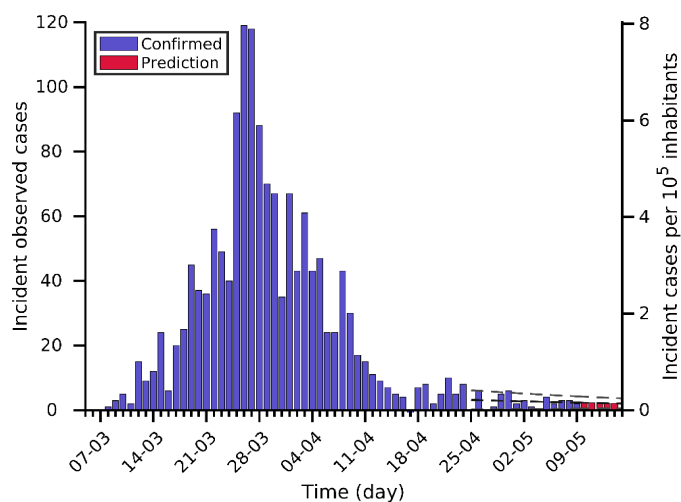
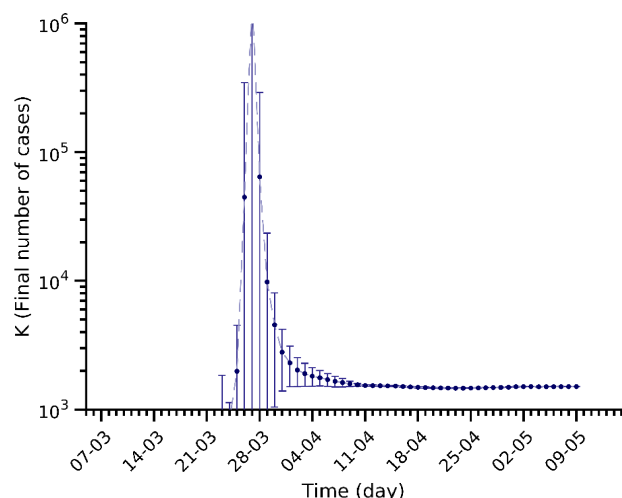
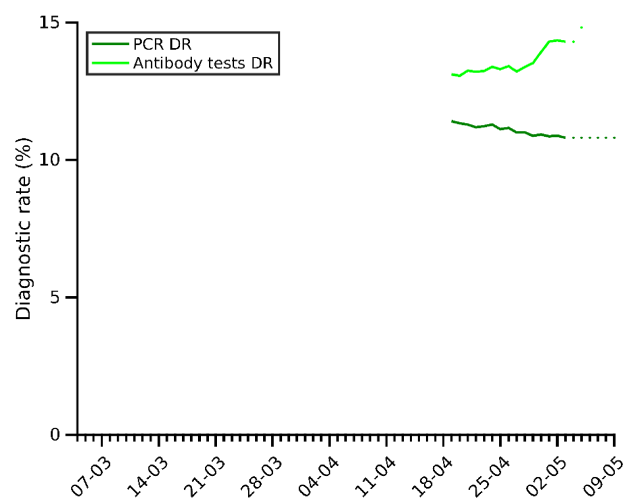
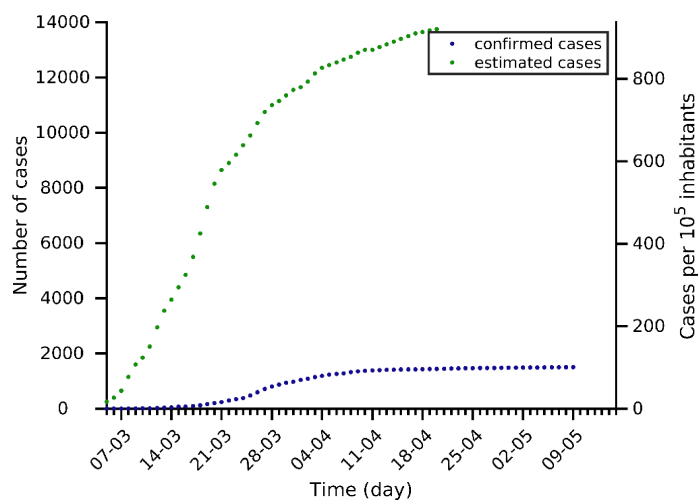
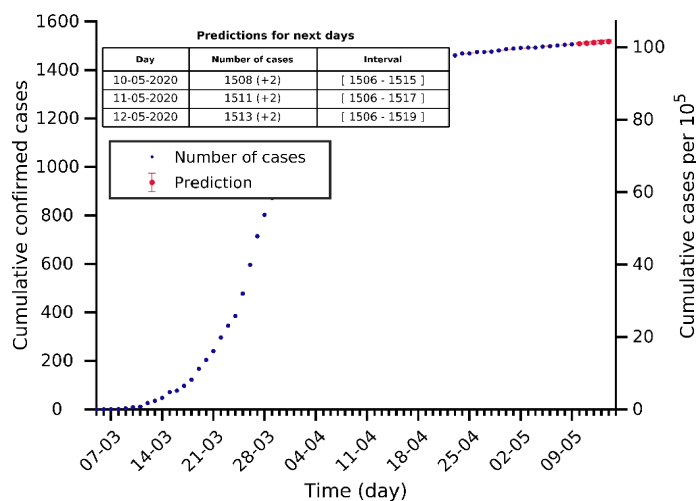
# Cantabria 09-05-2020. Population: 0.6M. Current cumulated incidence: 386/10<sup>5</sup>



# Baleares 09-05-2020. Population: 1.1M. Current cumulated incidence: 169/10<sup>5</sup>



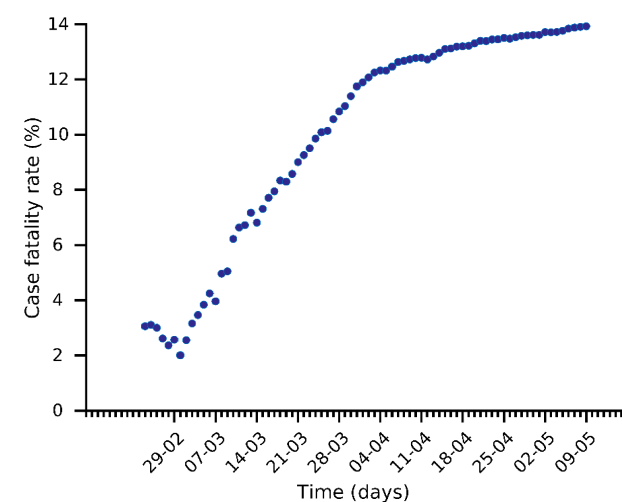
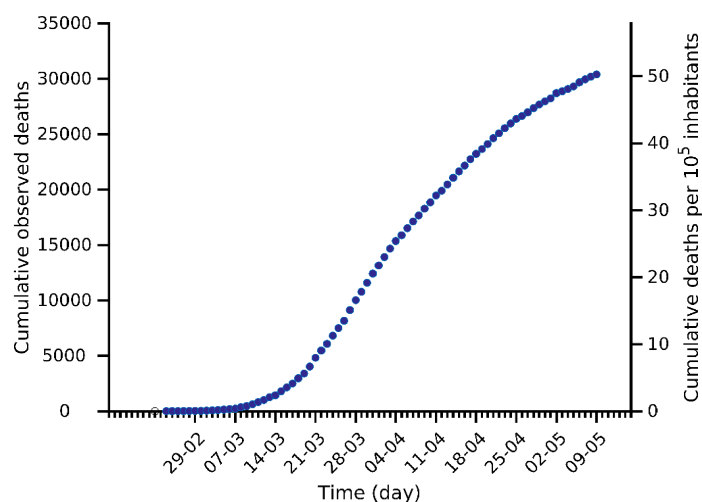
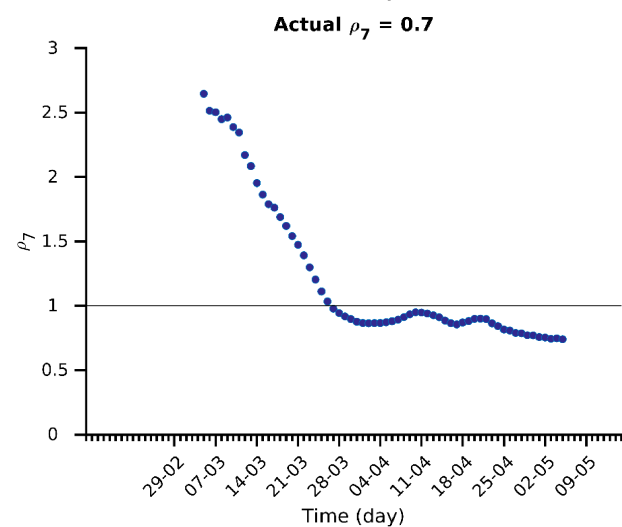
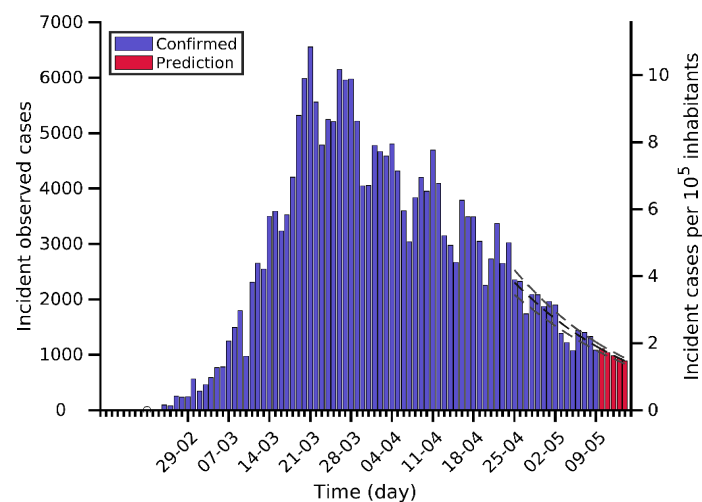
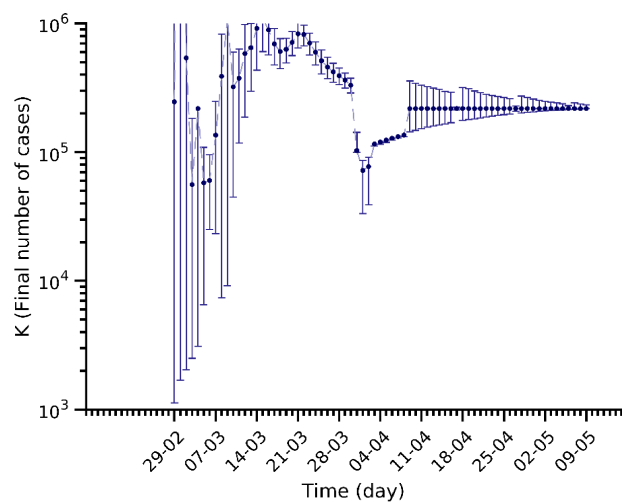
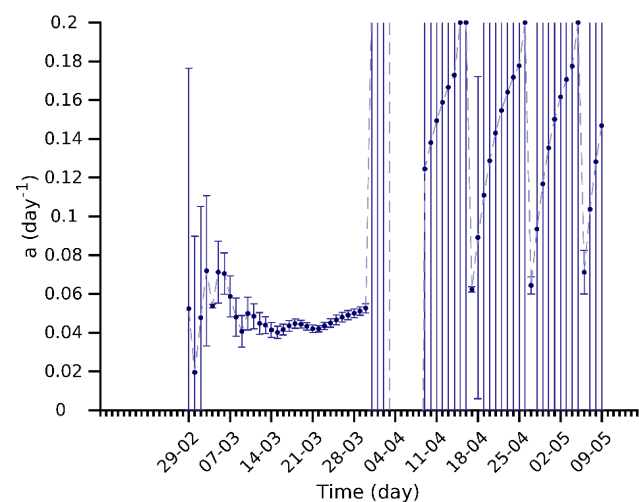
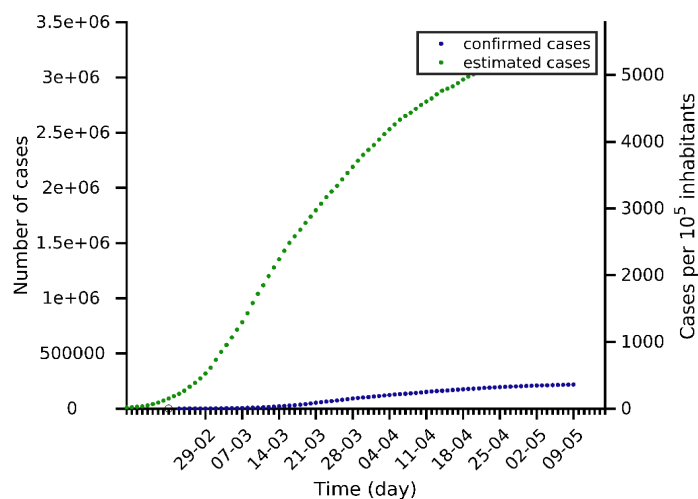
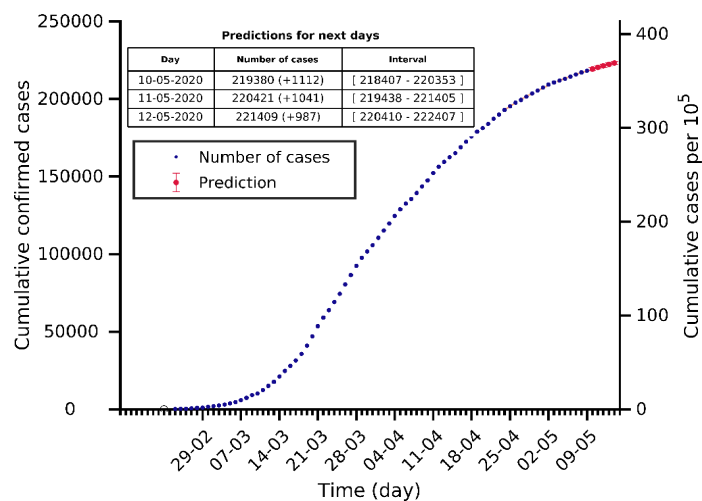
# Murcia 09-05-2020. Population: 1.5M. Current cumulated incidence: 101/10<sup>5</sup>



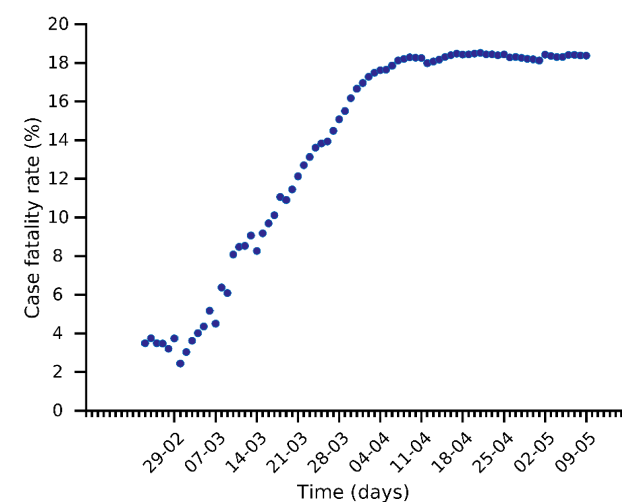
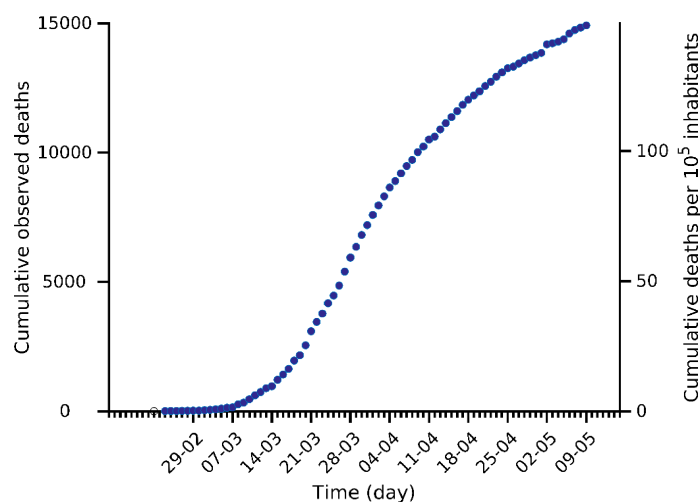
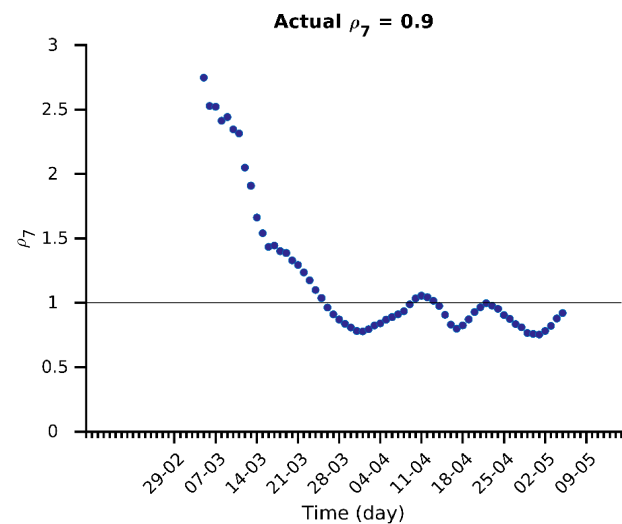
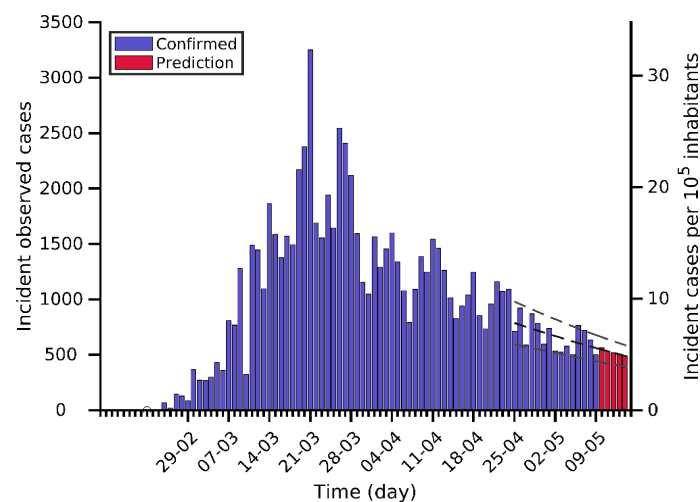
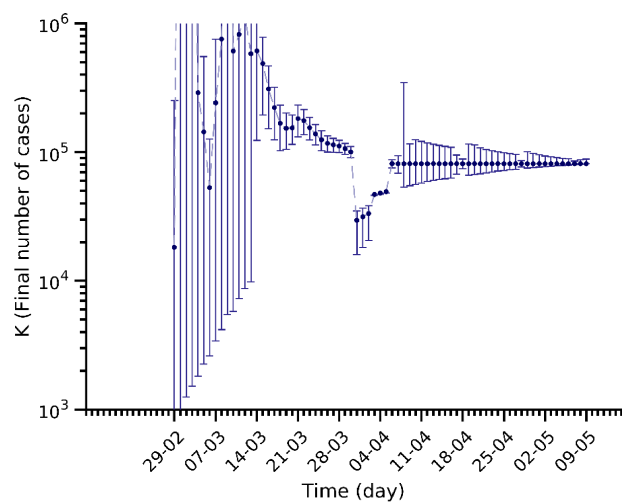
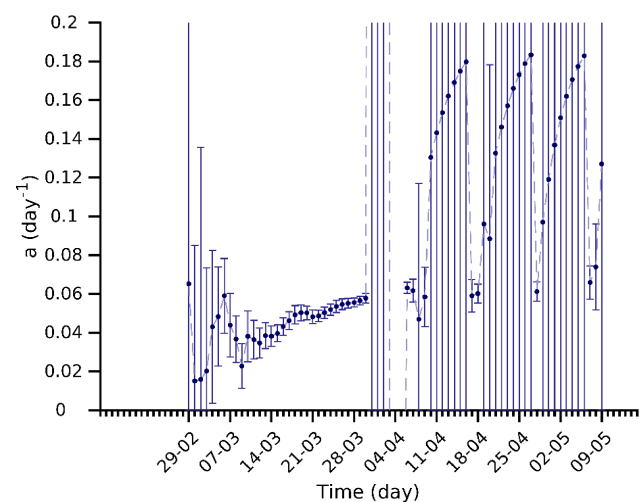
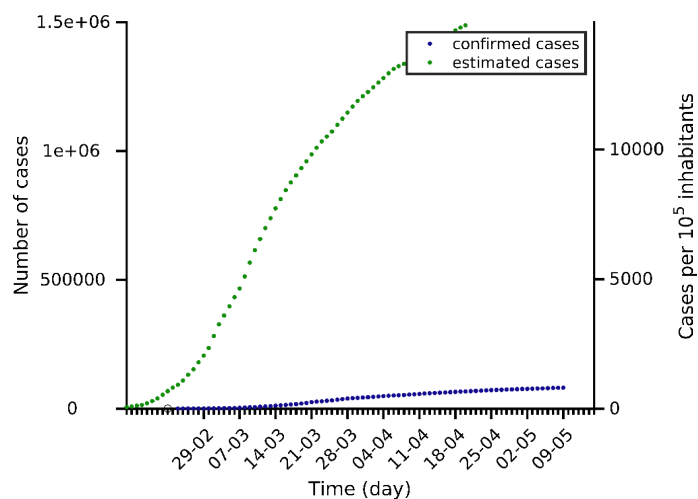
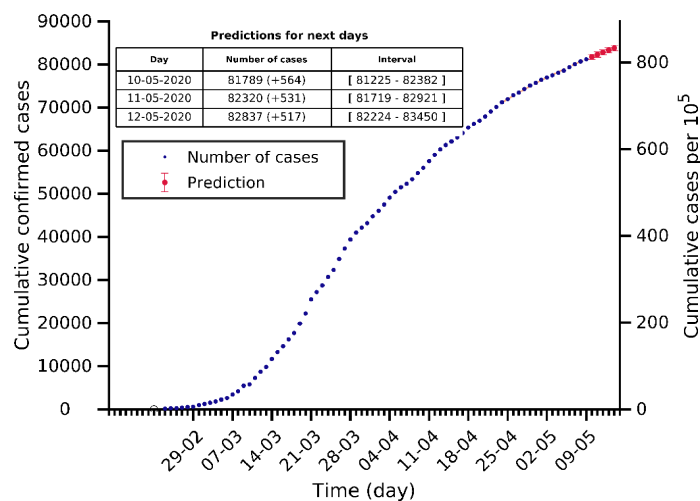
## **(4) Analysis and prediction of COVID-19 for Italy and its regions**

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

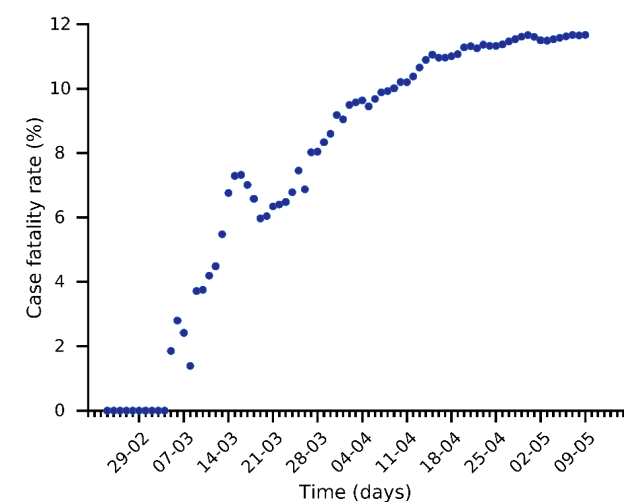
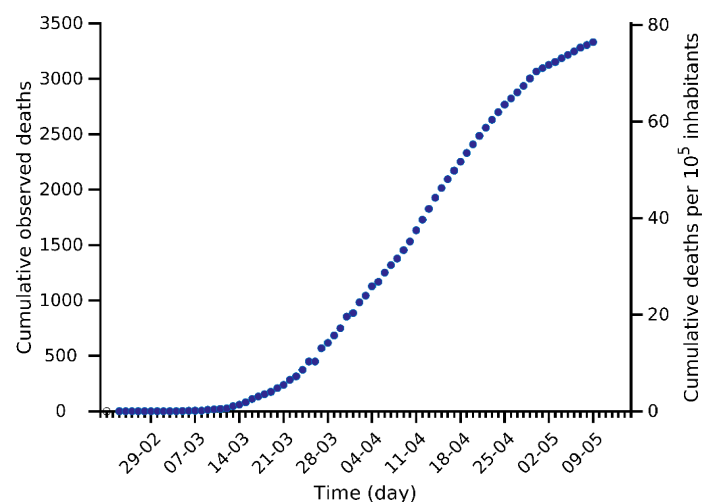
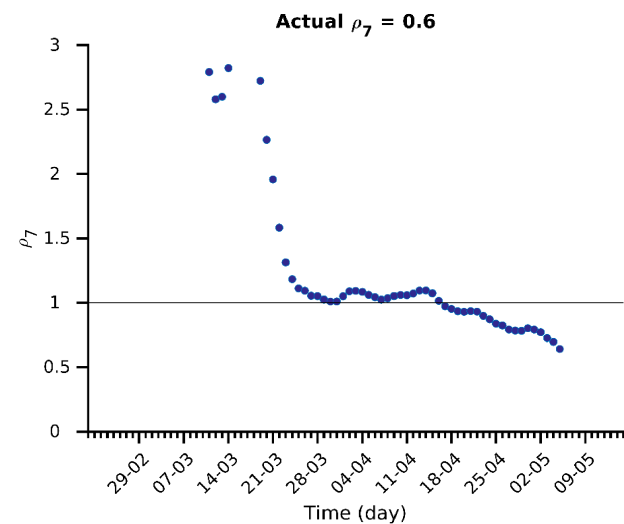
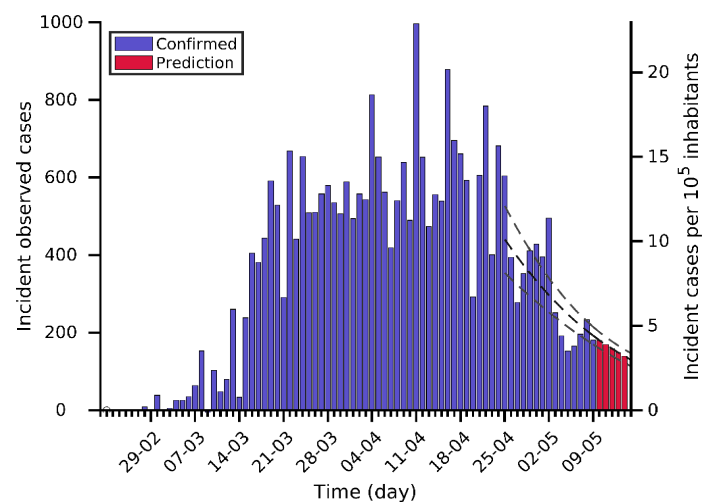
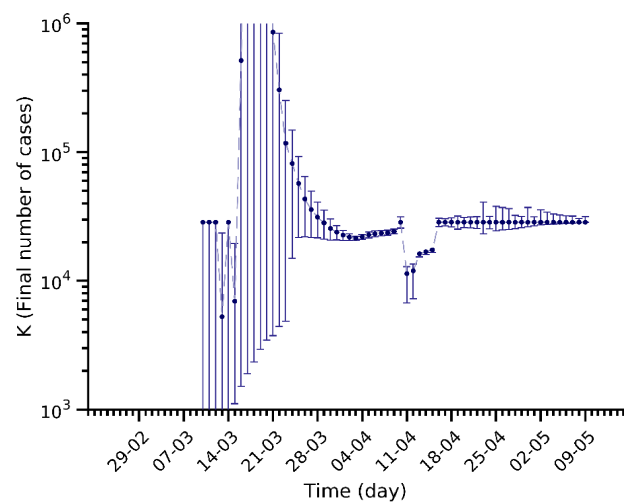
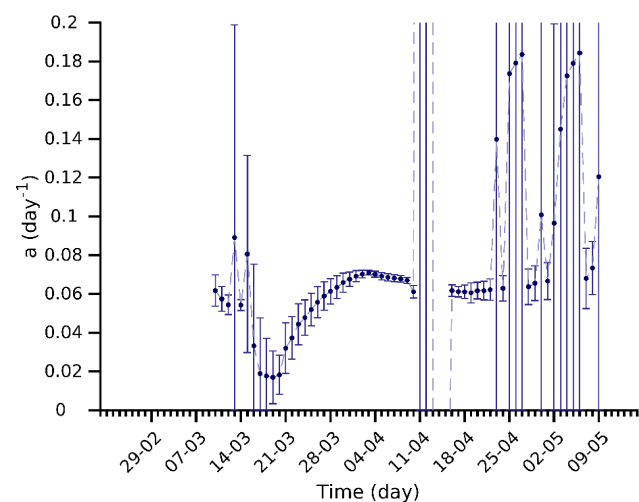
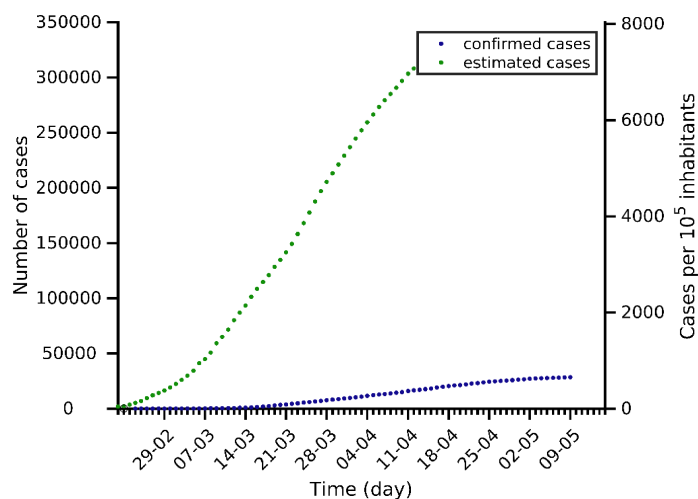
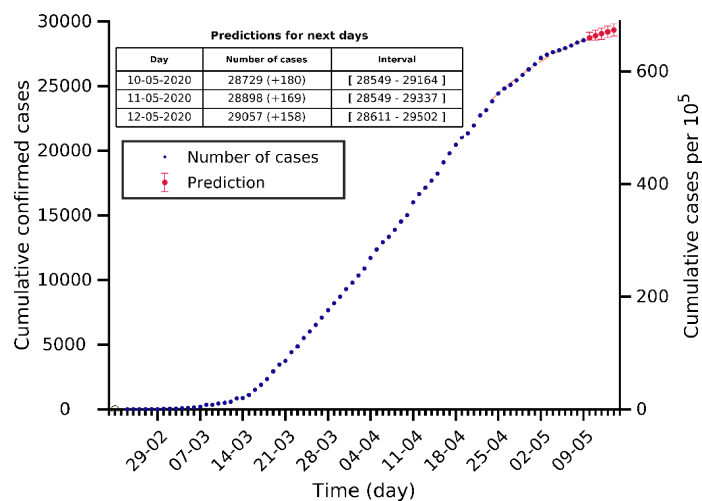
# Italy 09-05-2020. Population: 60.5M. Current cumulated incidence: 361/10<sup>5</sup>



# Lombardia 09-05-2020. Population: 10.1M. Current cumulated incidence: 807/10<sup>5</sup>

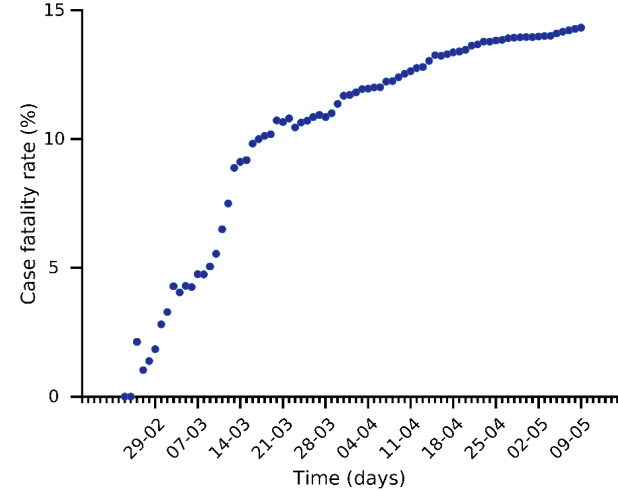
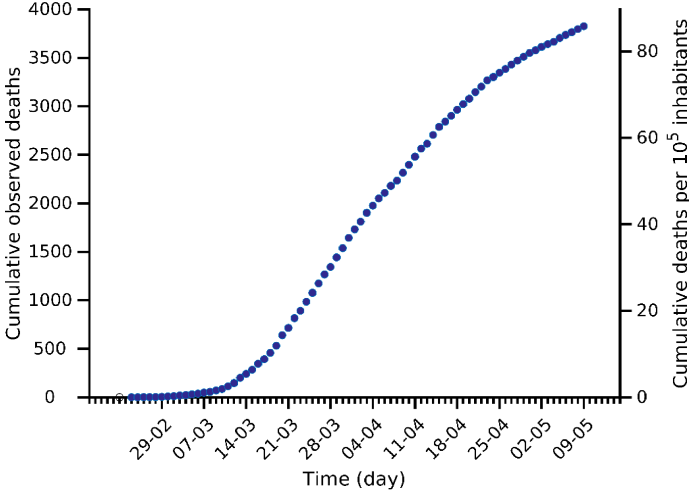
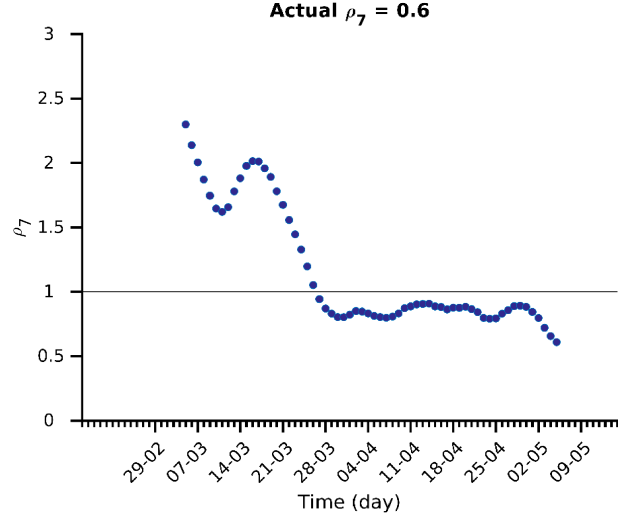
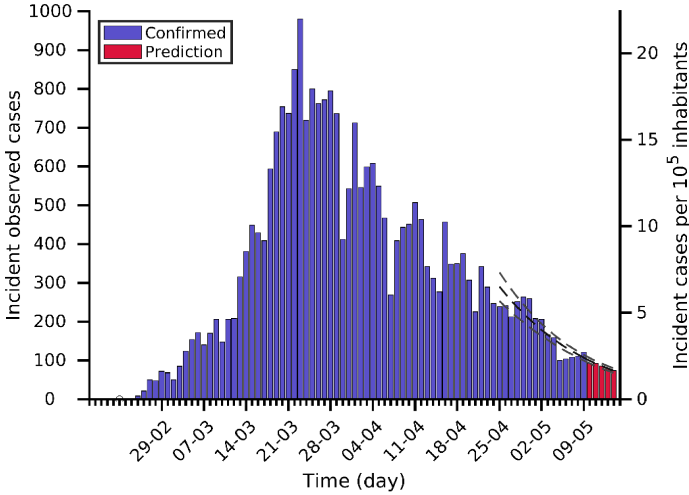
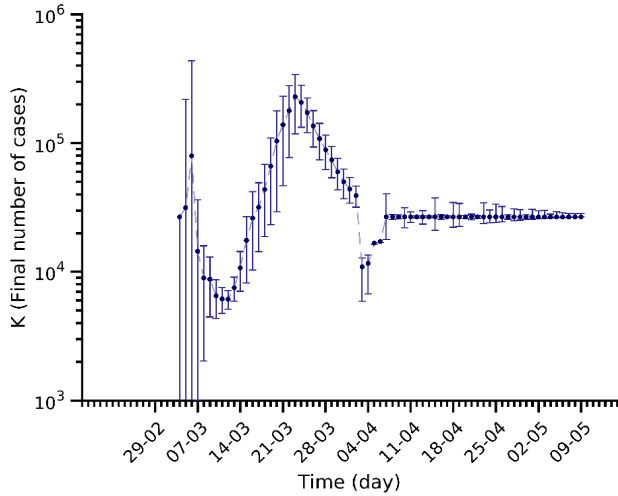
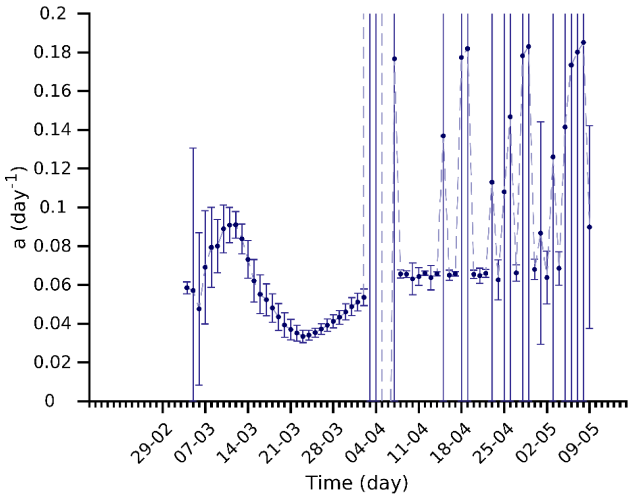
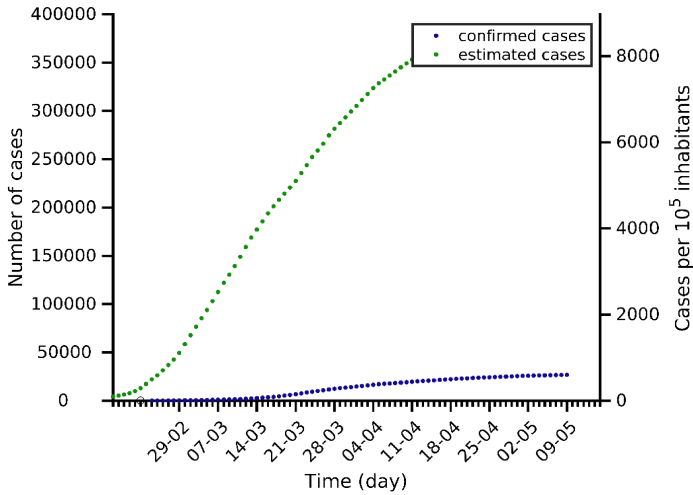
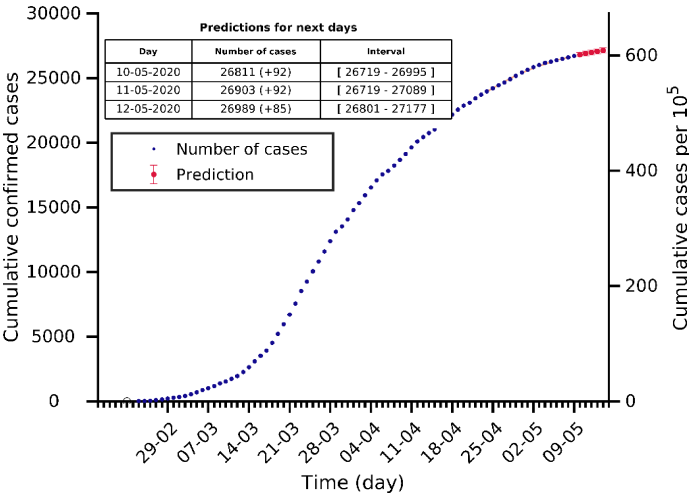


# Piemonte 09-05-2020. Population: 4.4M. Current cumulated incidence: 655/10<sup>5</sup>

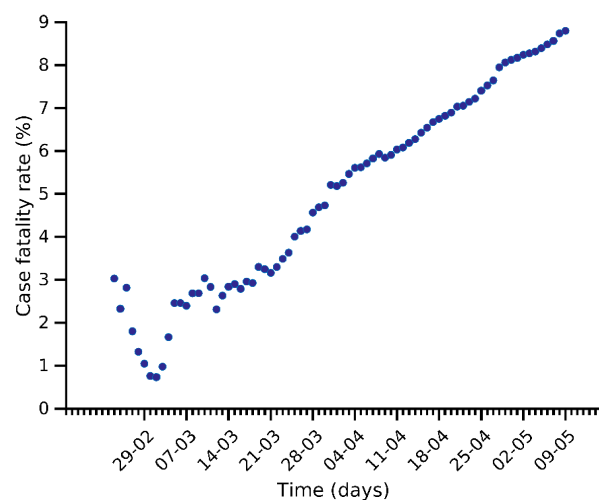
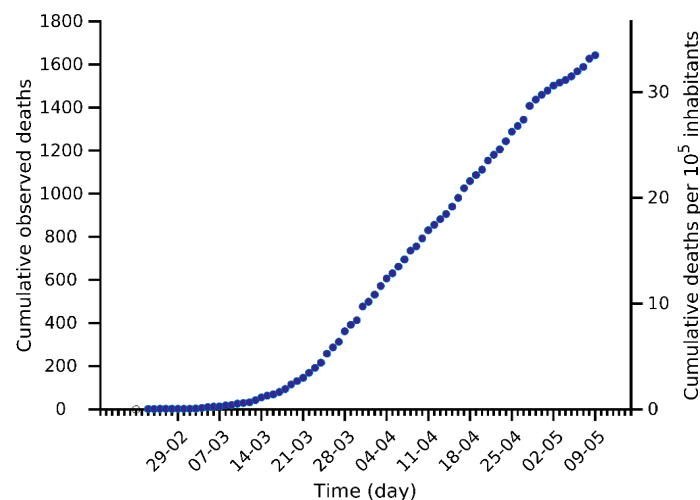
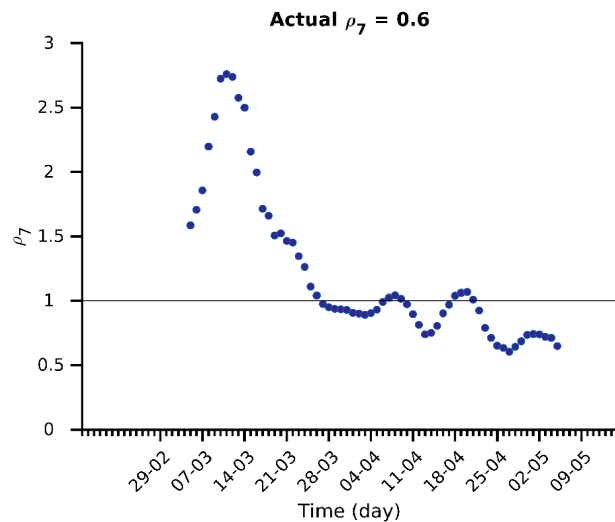
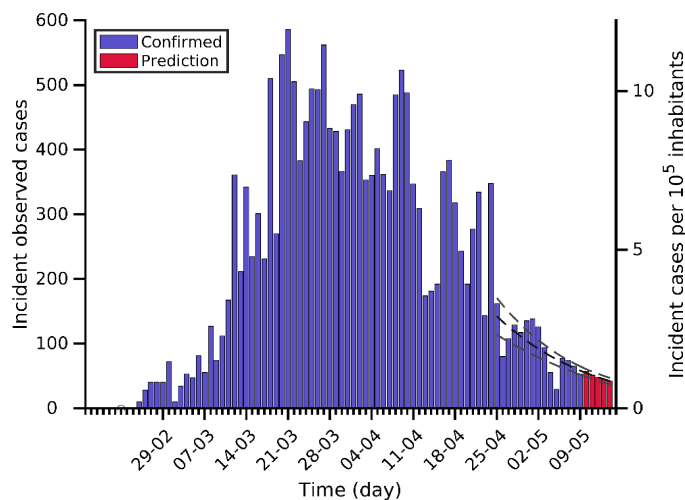
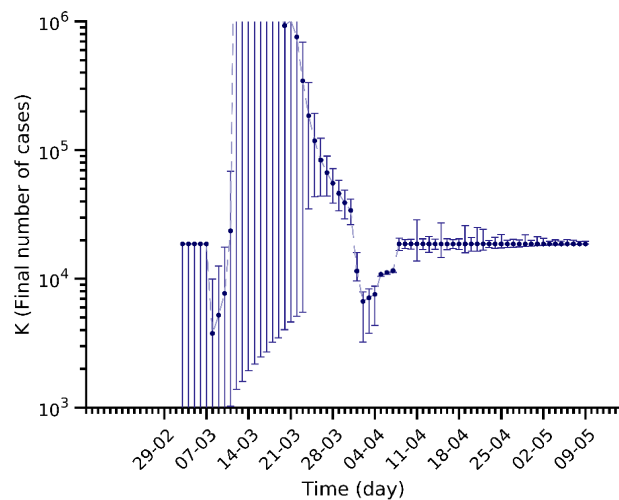
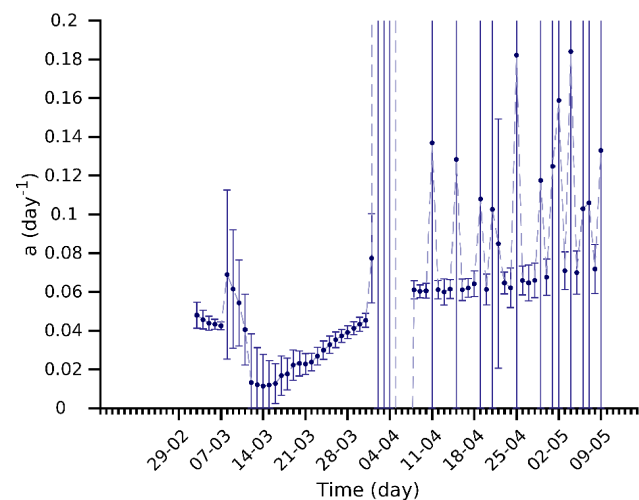
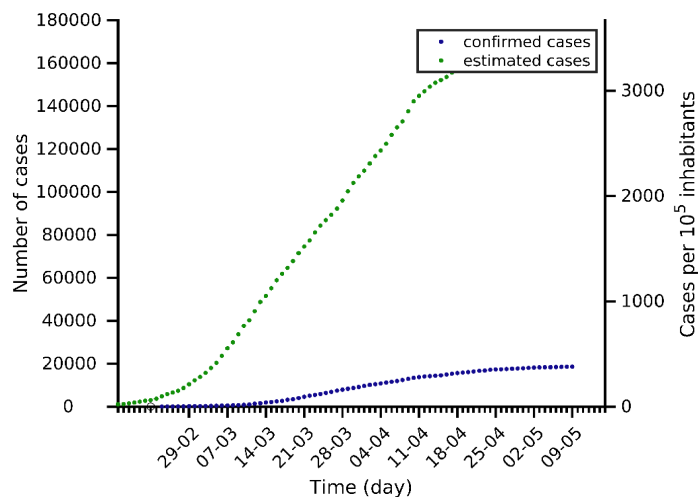
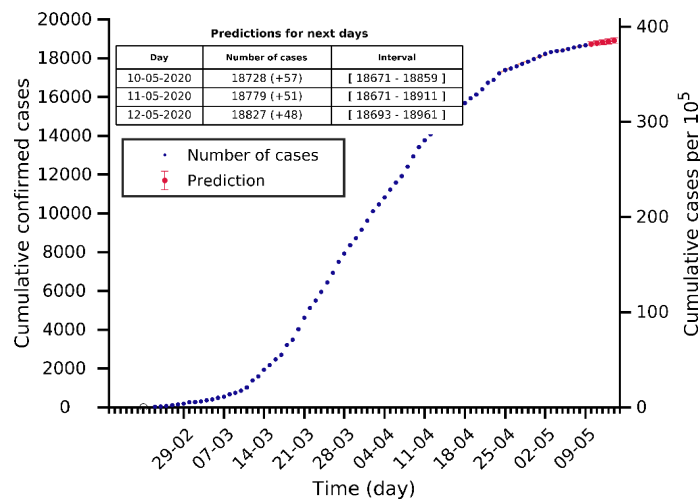




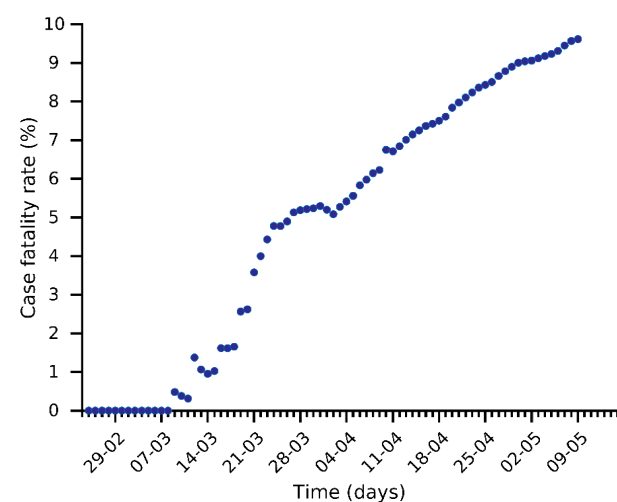
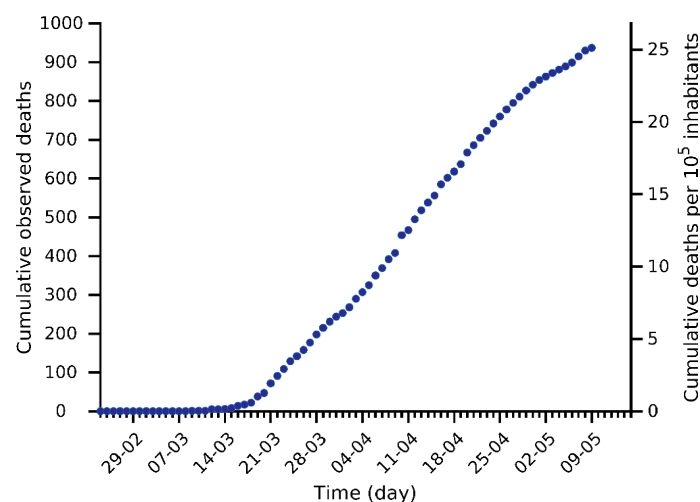
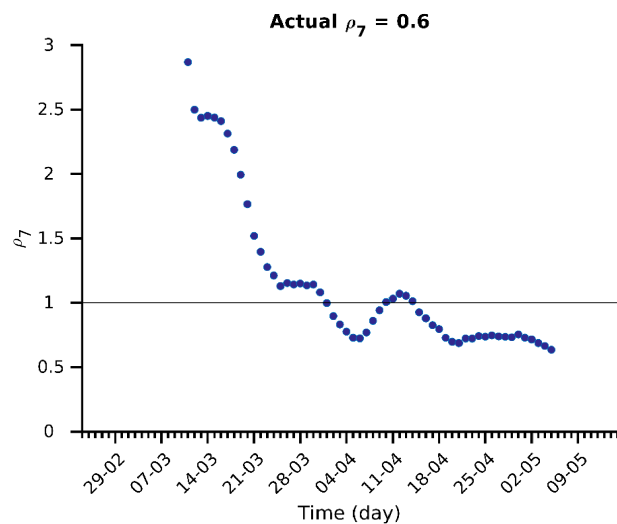
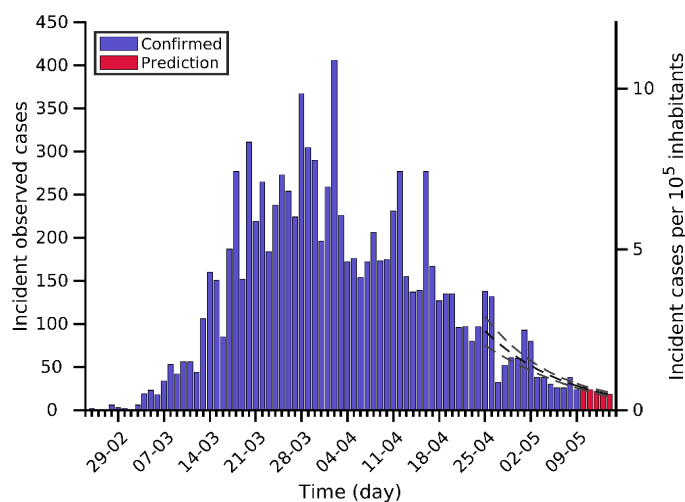
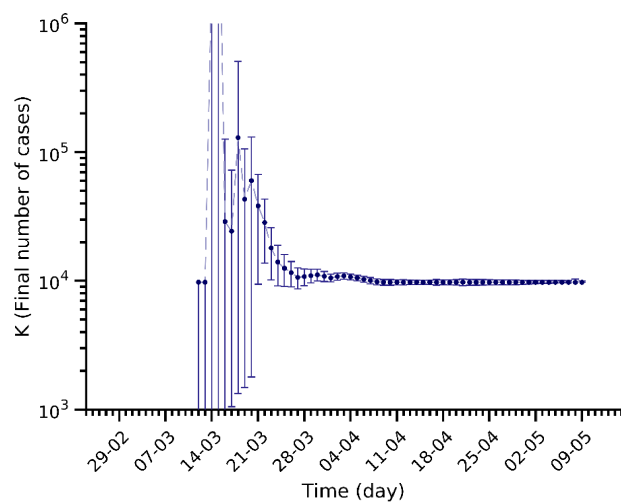
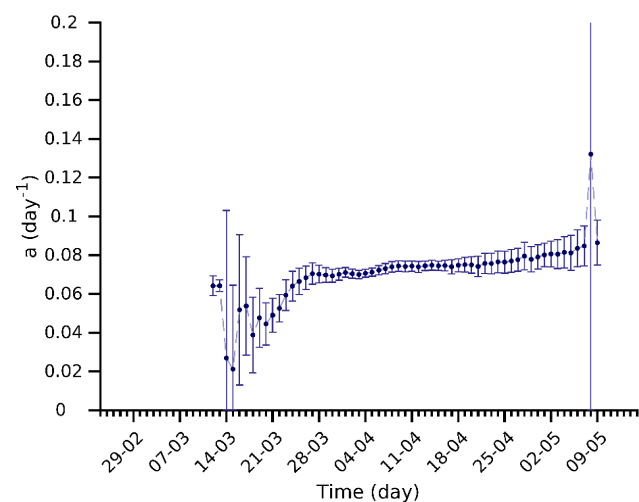
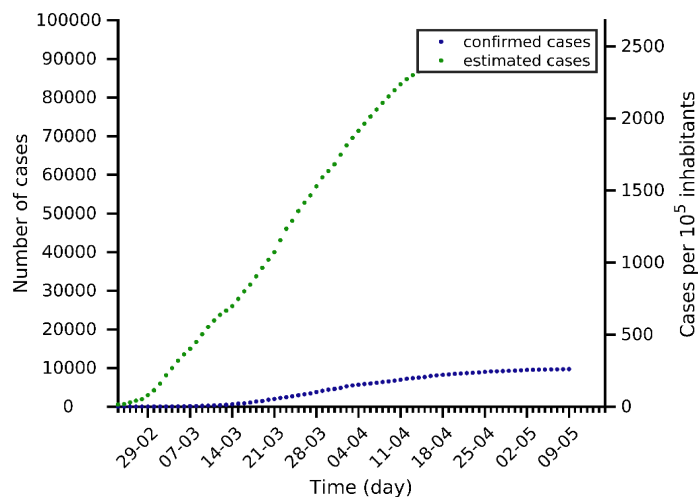
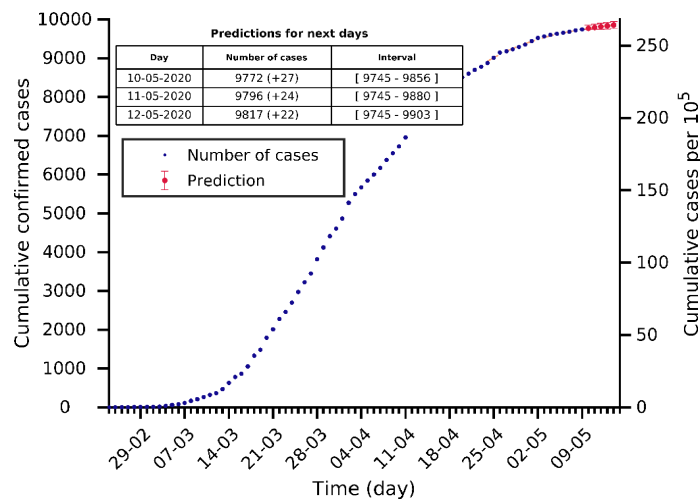
Emilia Romagna 09-05-2020. Population: 4.5M. Current cumulated incidence: 599/100000



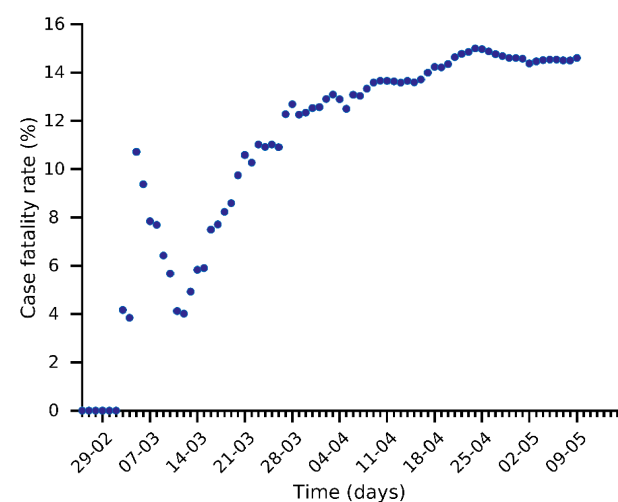
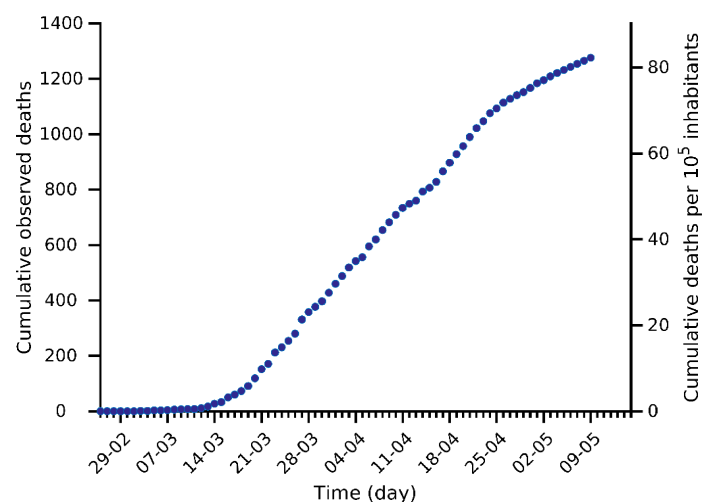
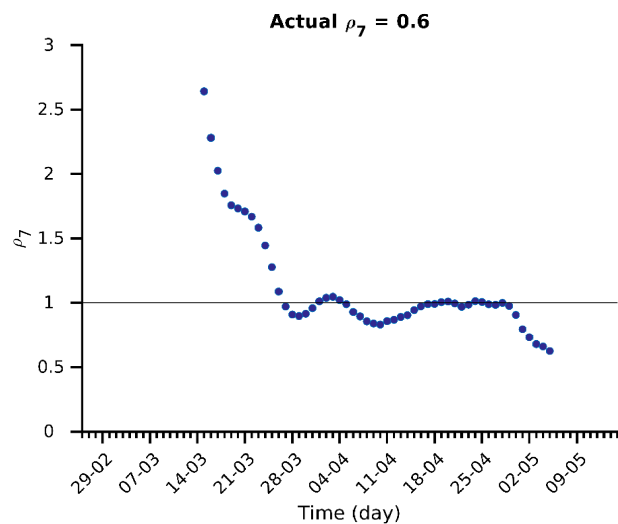
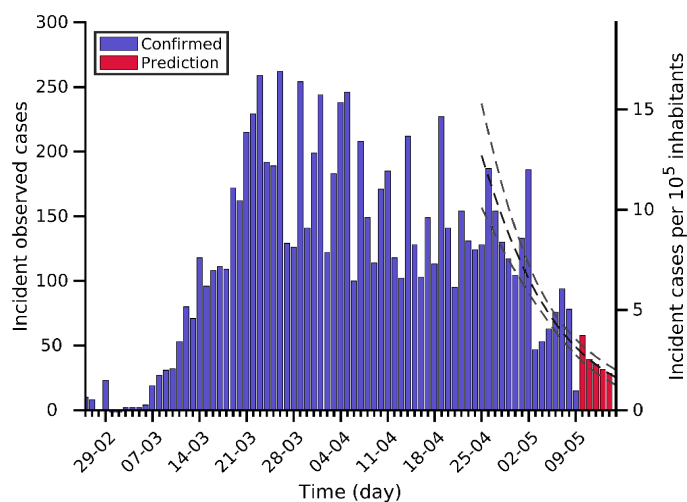
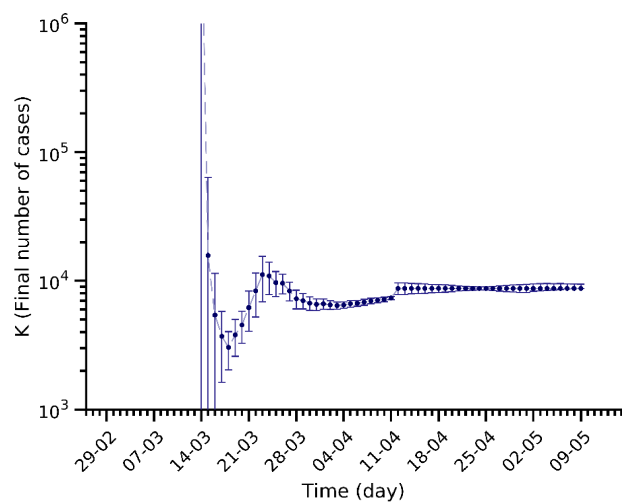
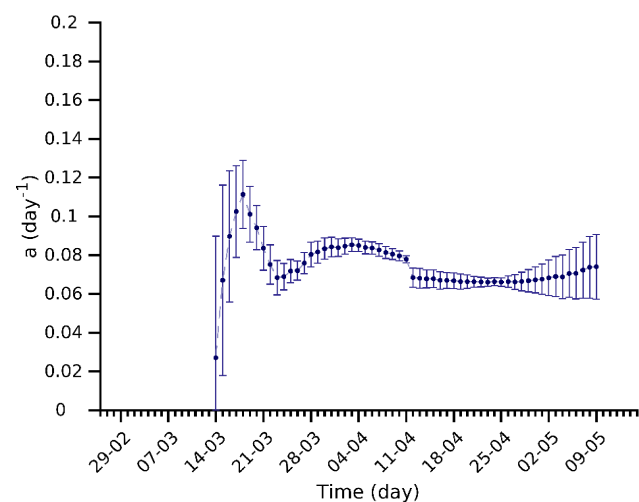
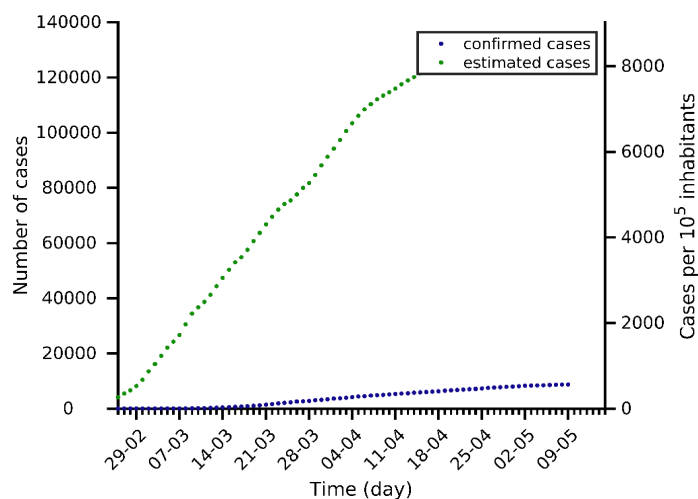
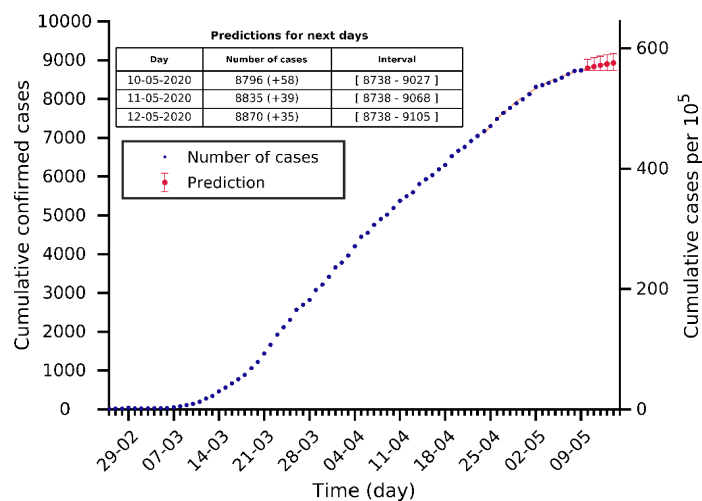
# Veneto 09-05-2020. Population: 4.9M. Current cumulated incidence: 381/10<sup>5</sup>



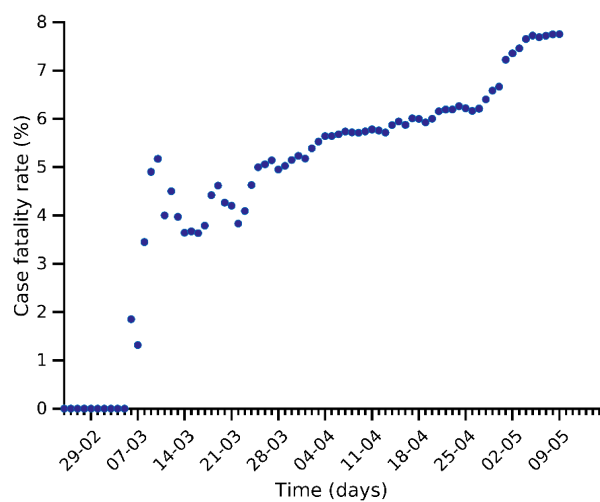
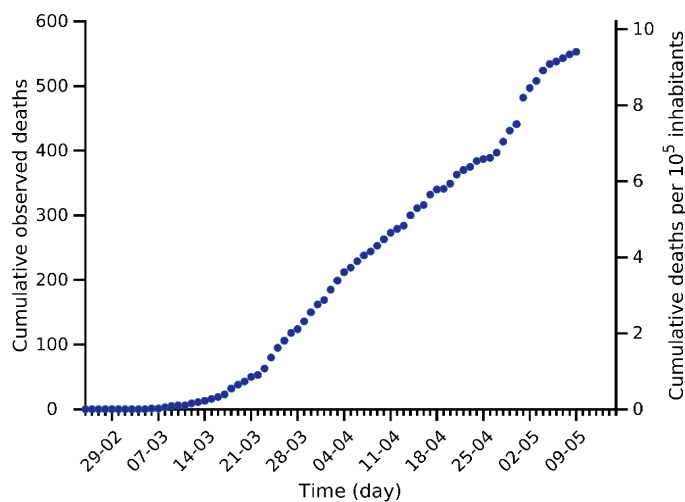
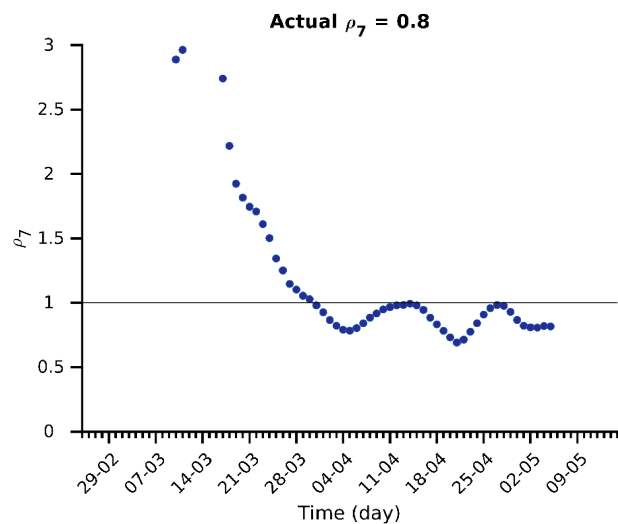
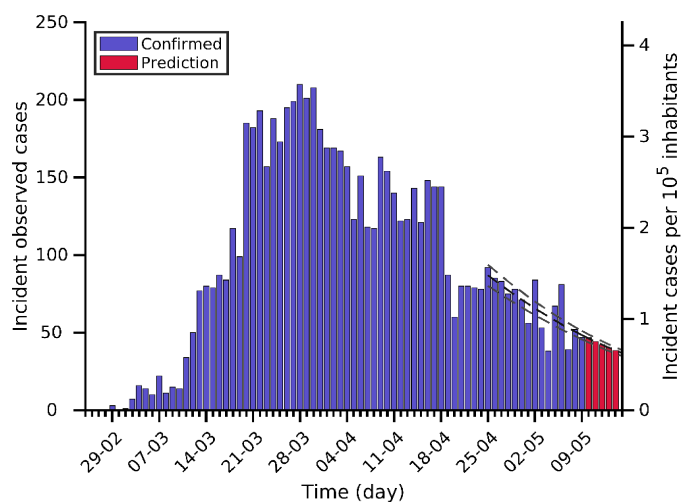
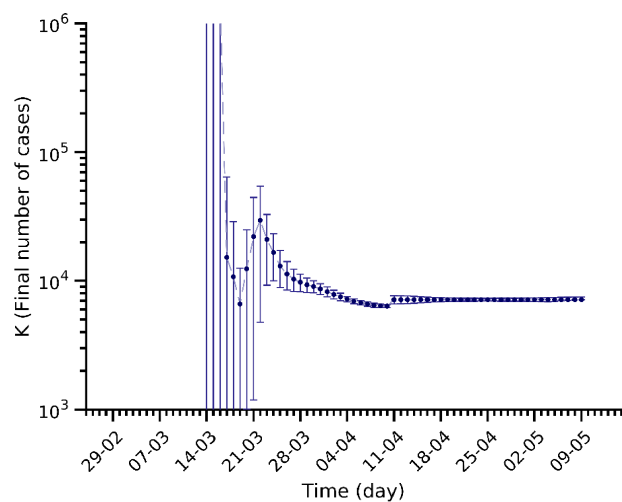
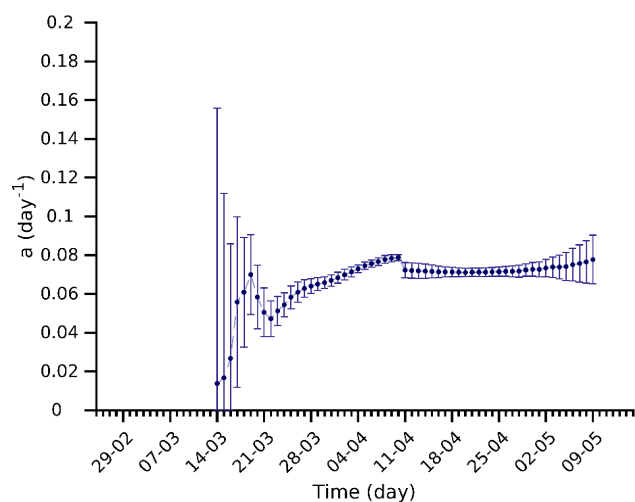
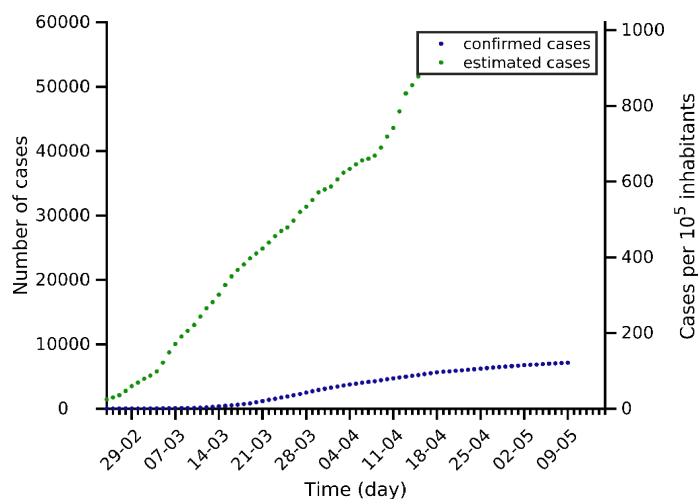
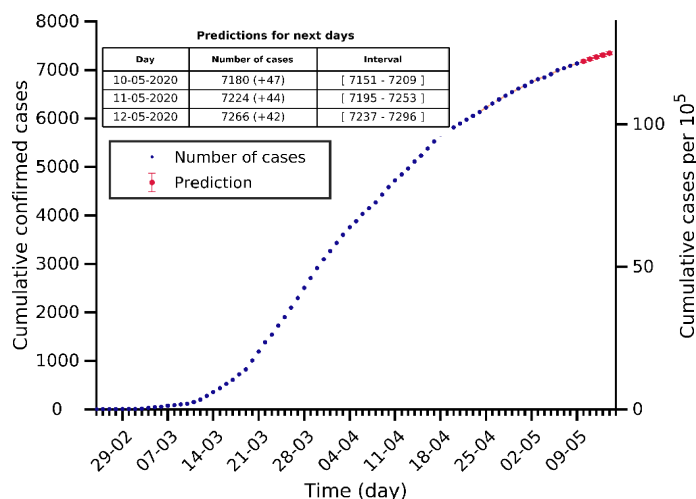
# Toscana 09-05-2020. Population: 3.7M. Current cumulated incidence: 261/10<sup>5</sup>



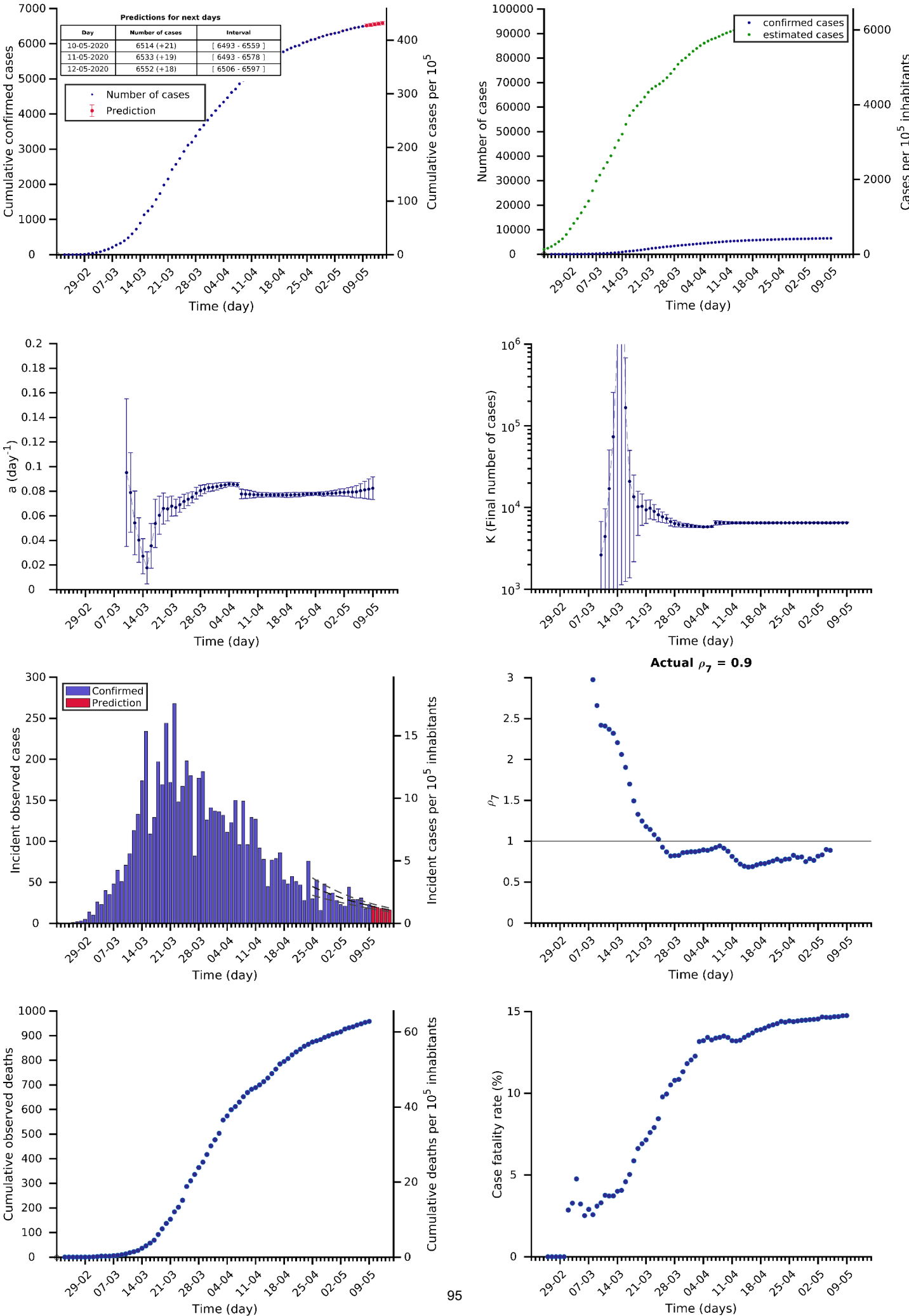
# Liguria 09-05-2020. Population: 1.6M. Current cumulated incidence: 563/10<sup>5</sup>



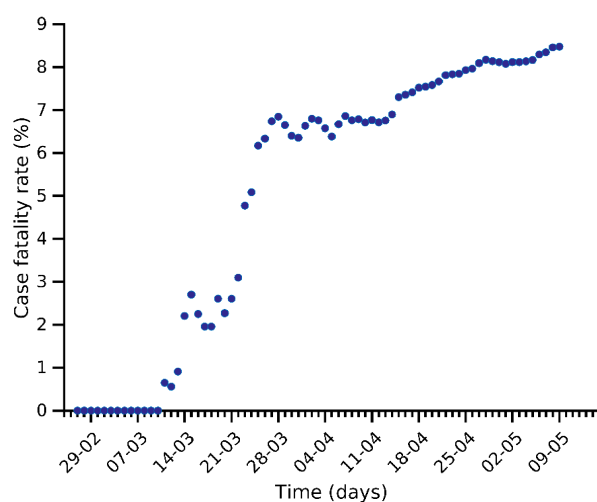
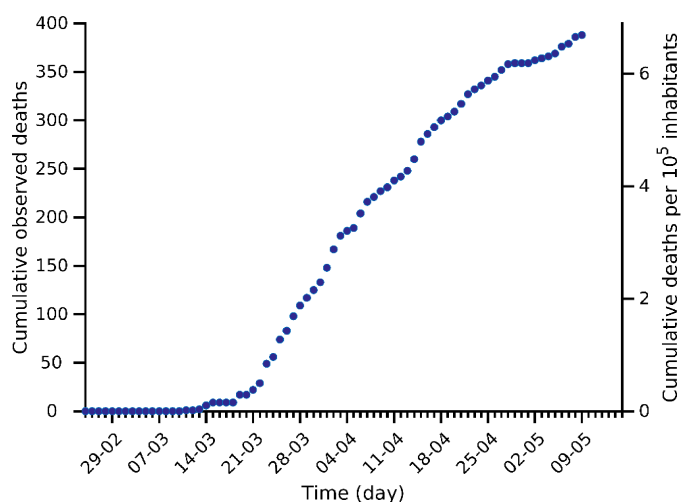
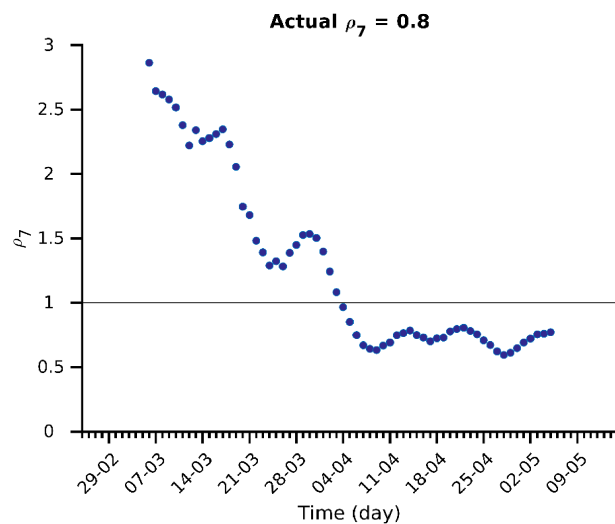
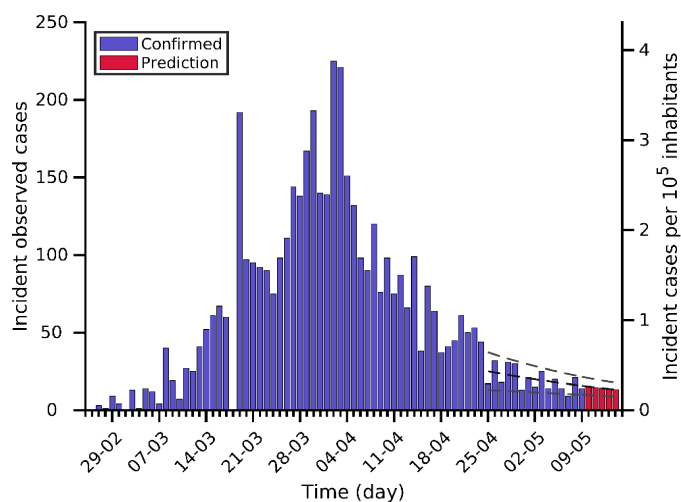
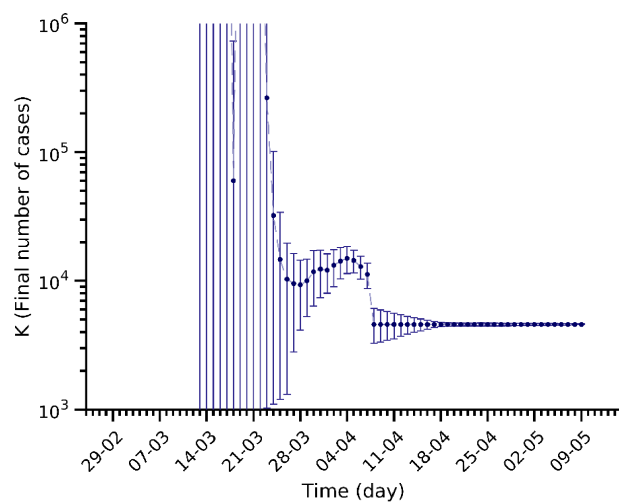
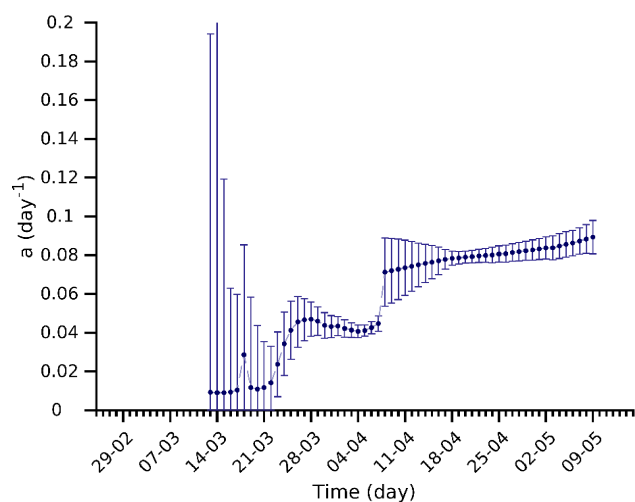
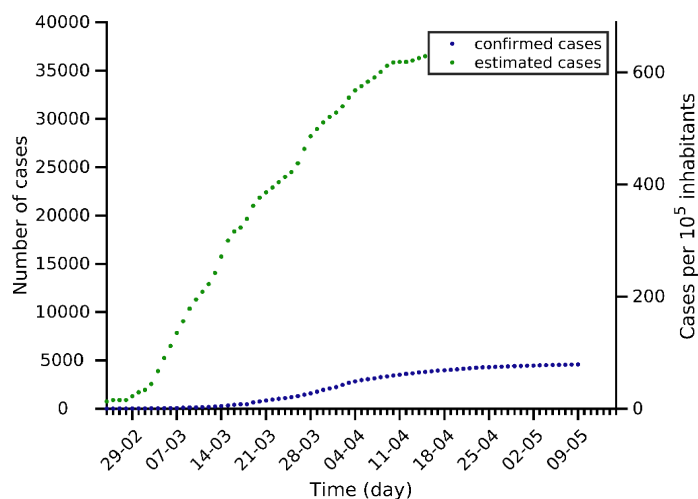
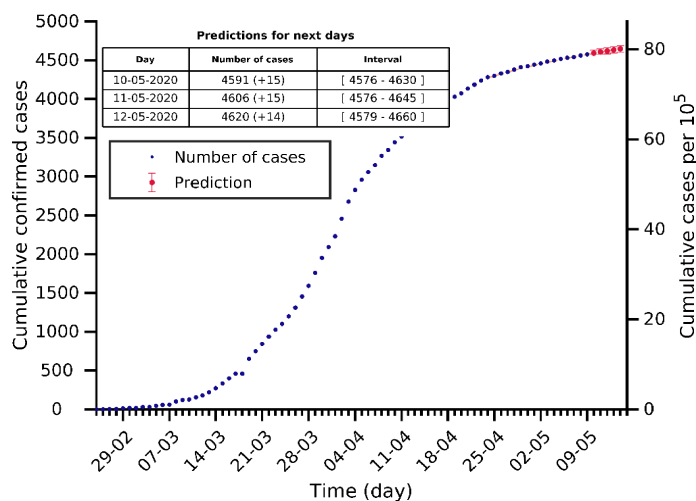
# Lazio 09-05-2020. Population: 5.9M. Current cumulated incidence: 121/10<sup>5</sup>



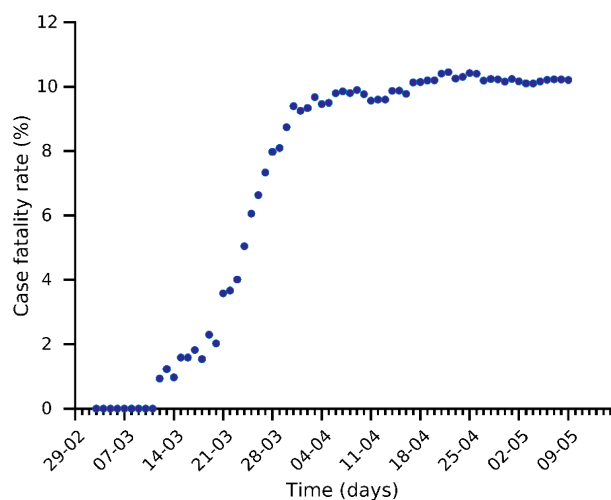
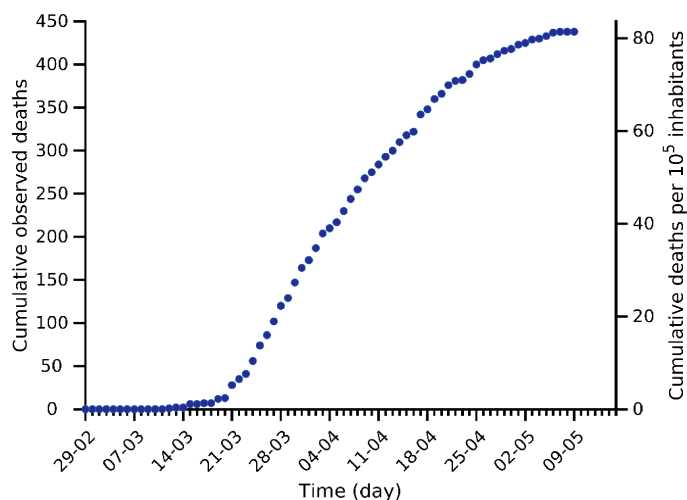
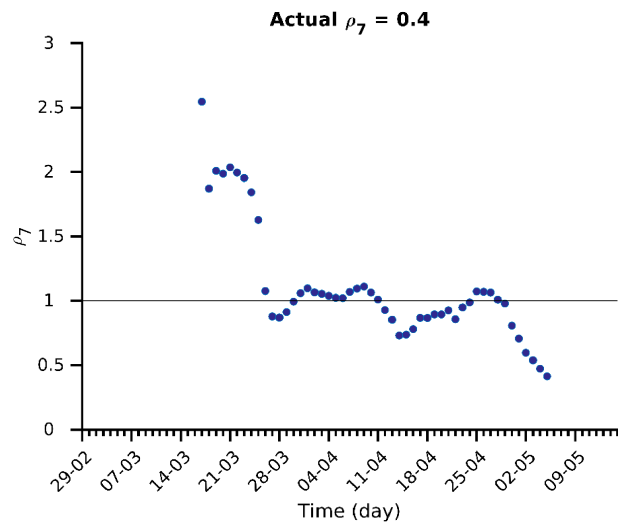
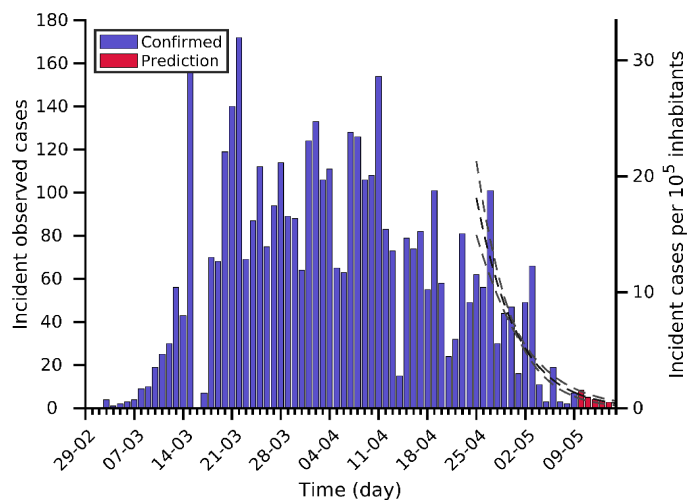
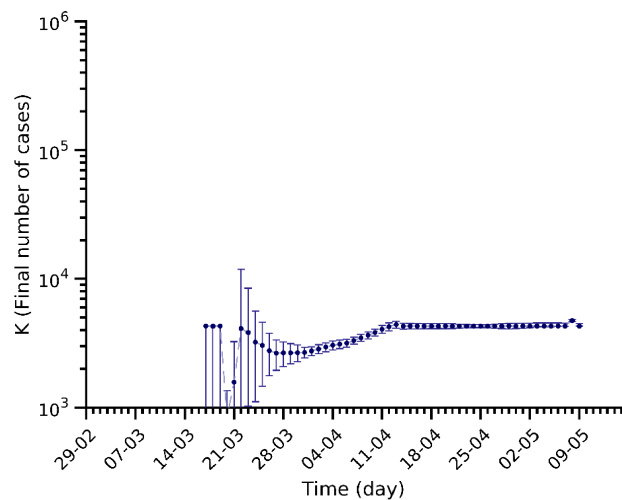
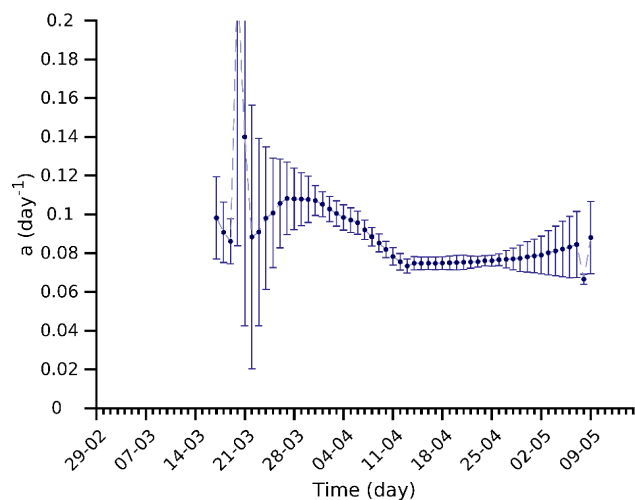
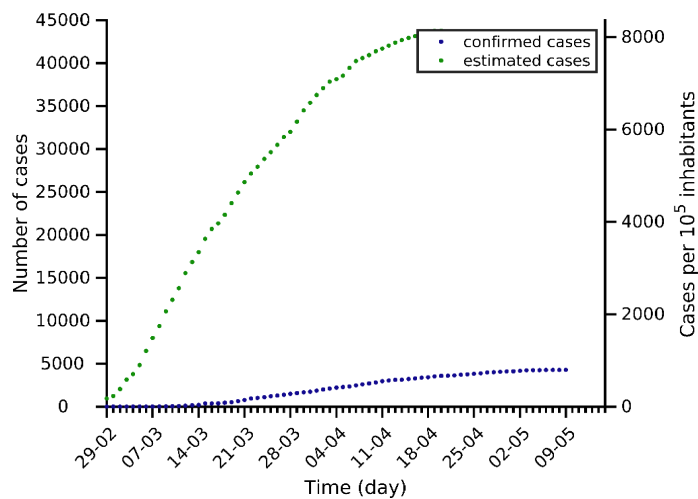
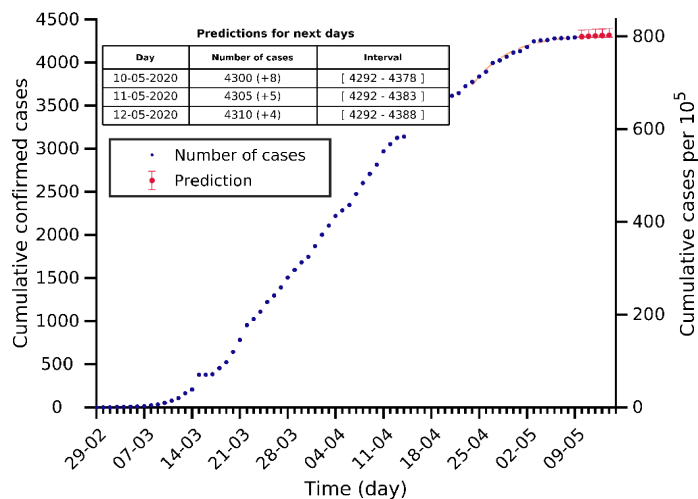
Marche
 09-05-2020.
 Population: 1.5M.
 Current cumulated incidence: 426/10<sup>5</sup>



# Campania 09-05-2020. Population: 5.8M. Current cumulated incidence: 79/10<sup>5</sup>

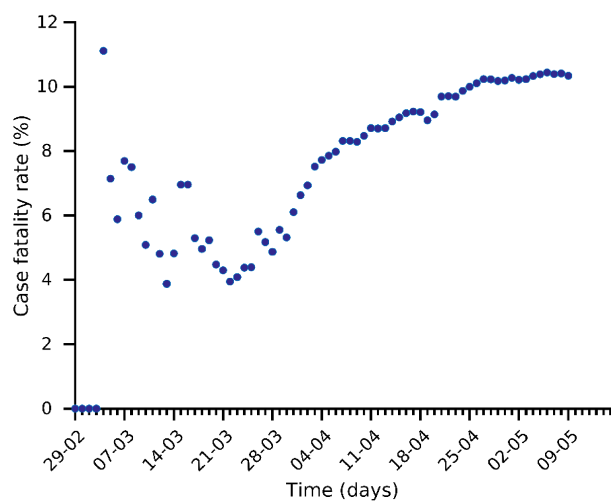
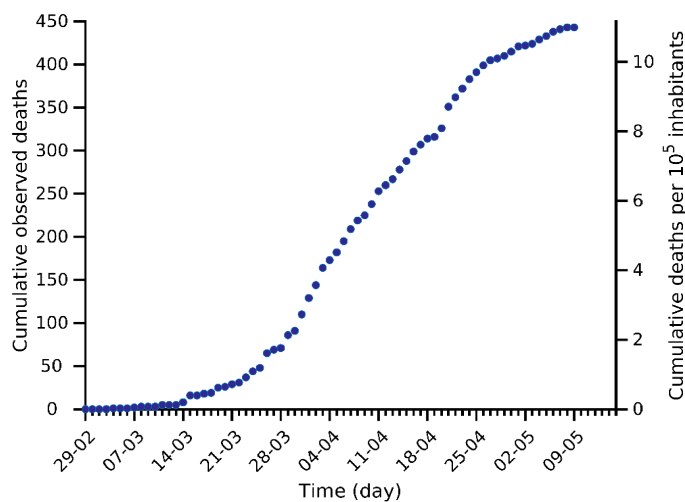
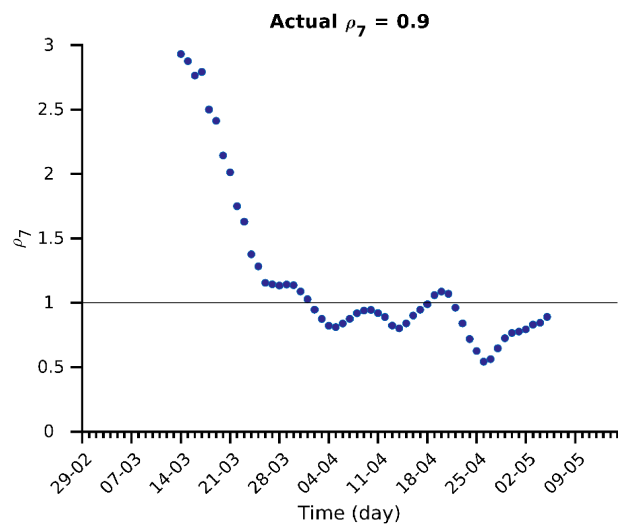
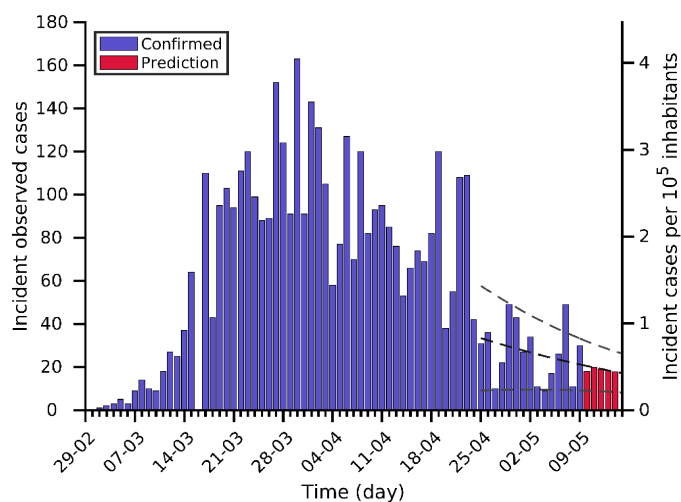
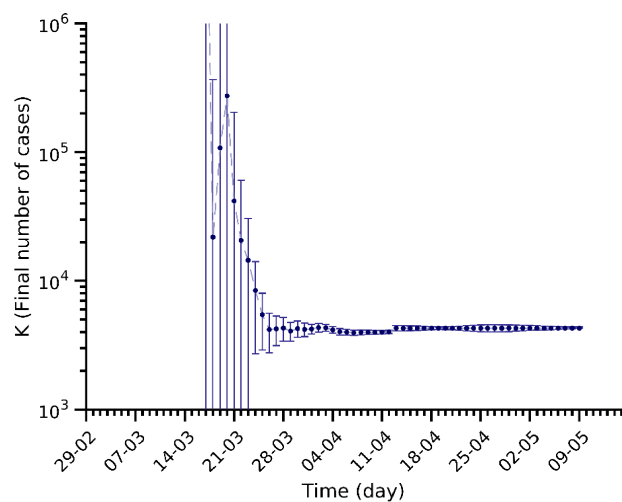
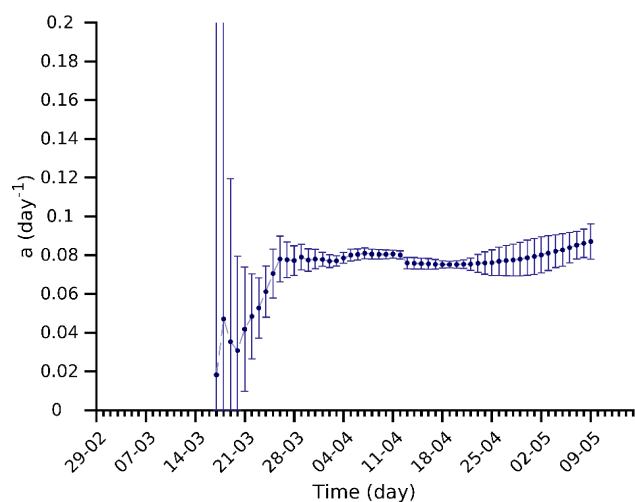
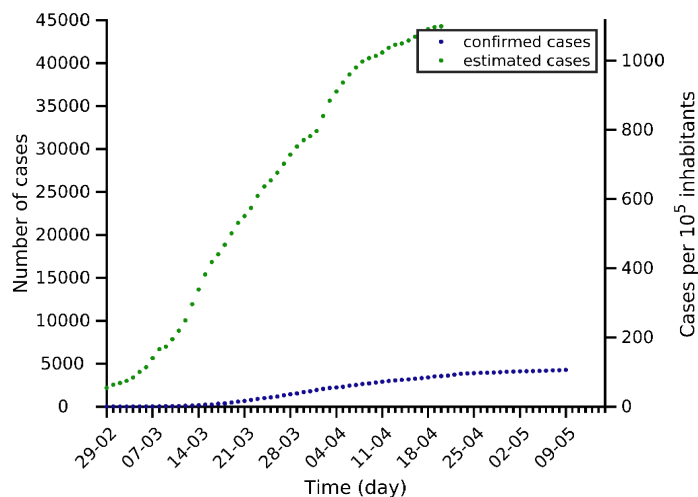
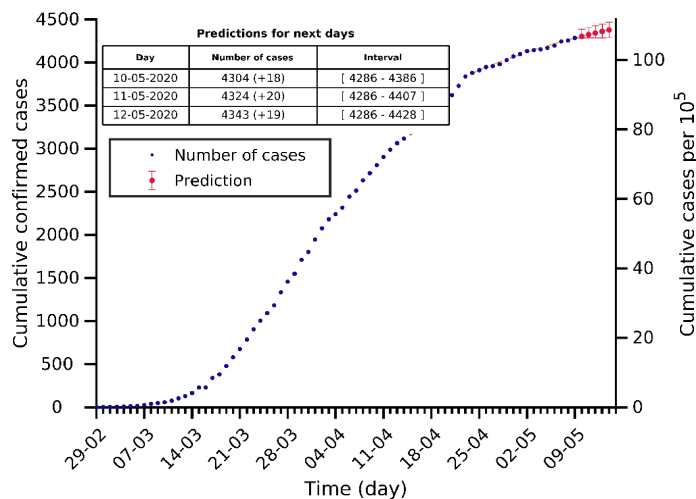


# Trento 09-05-2020. Population: 0.5M. Current cumulated incidence: 798/10<sup>5</sup>

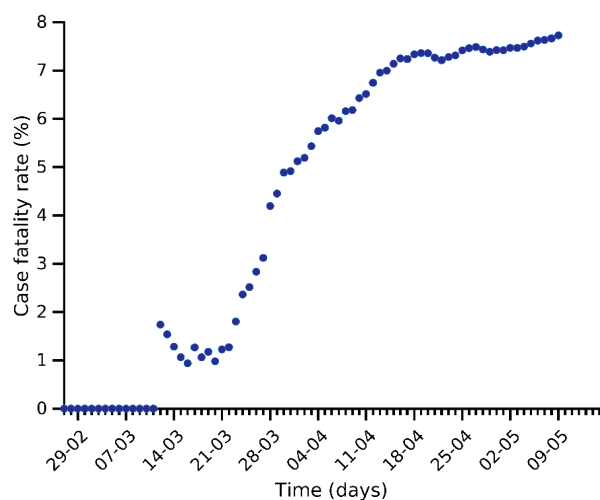
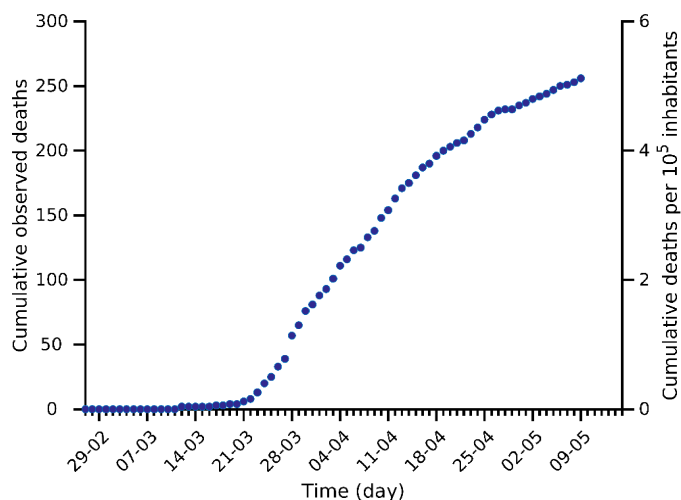
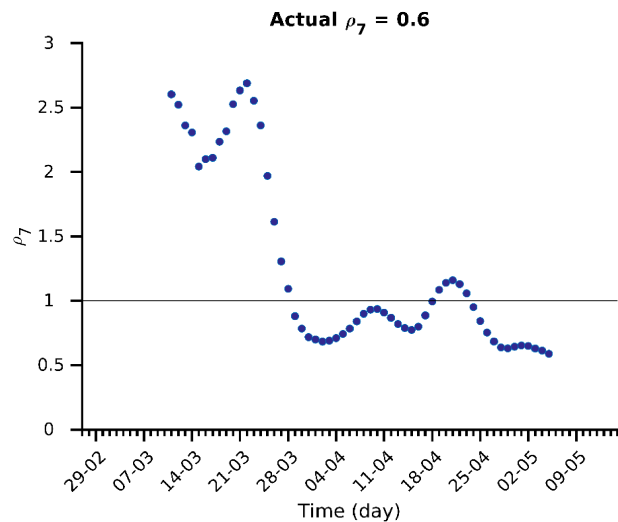
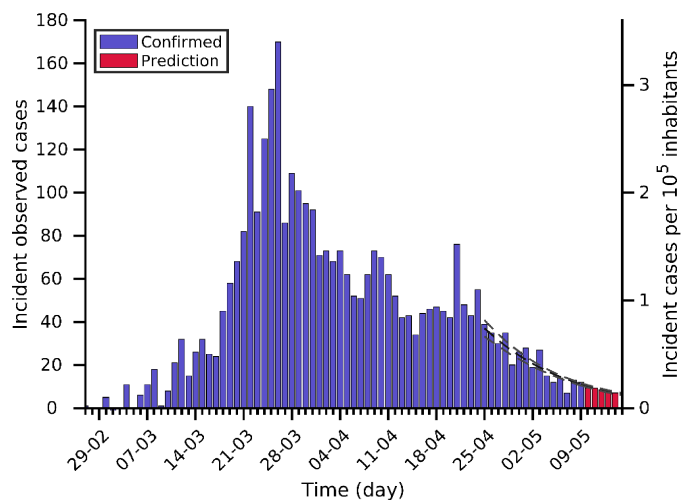
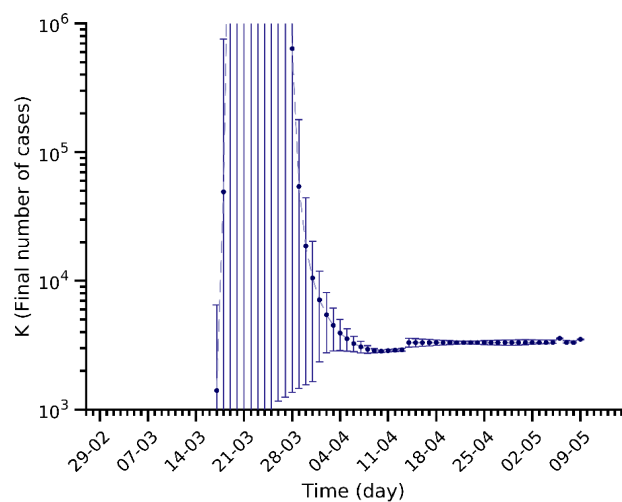
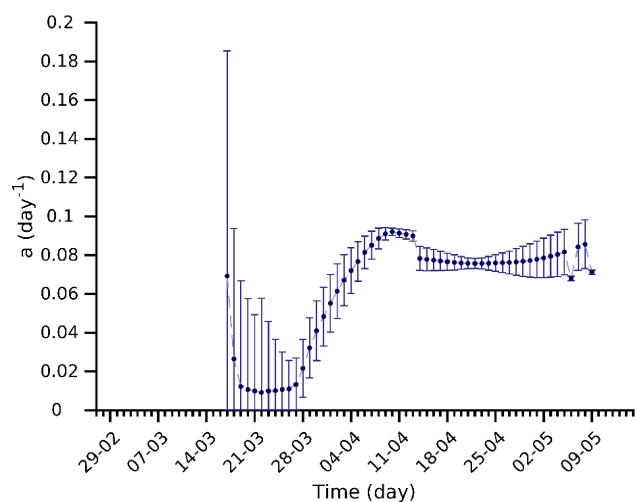
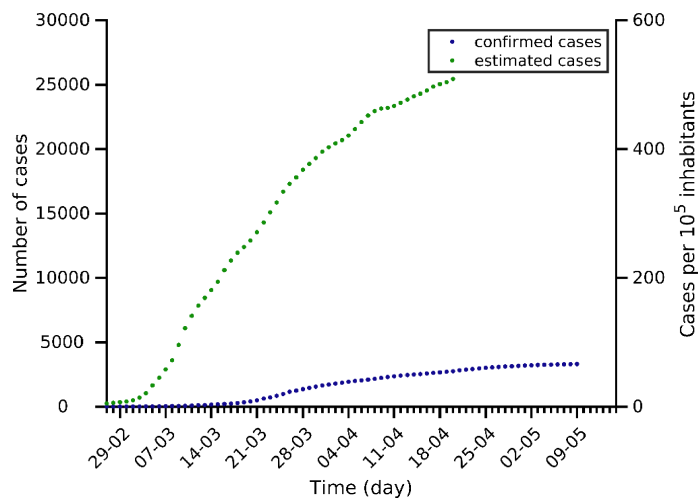
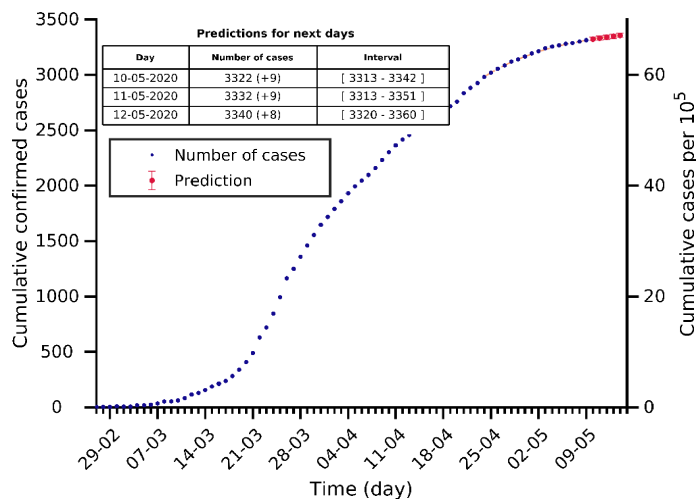




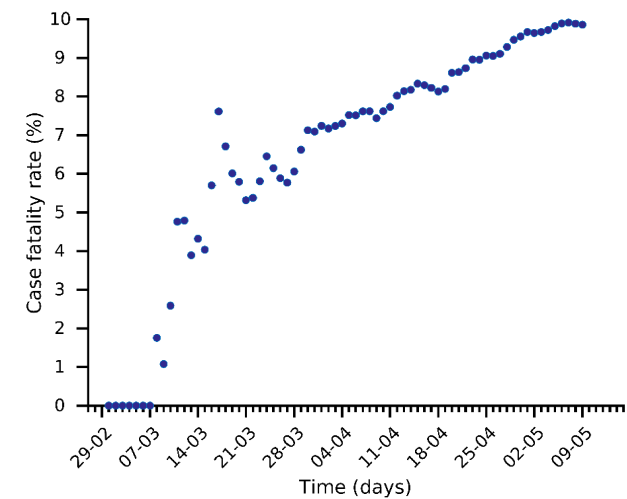
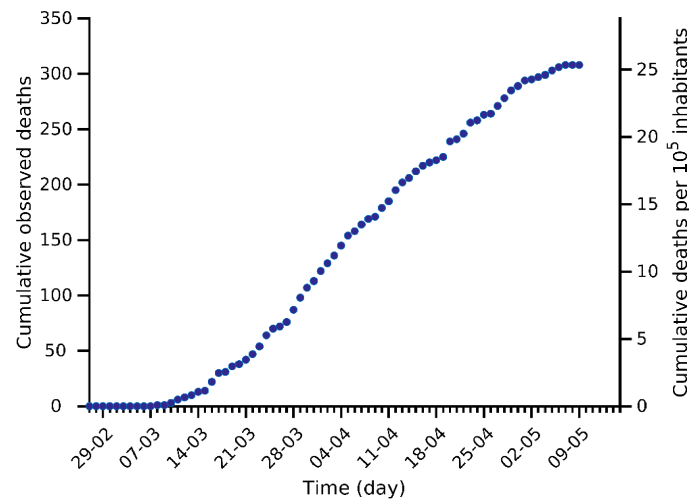
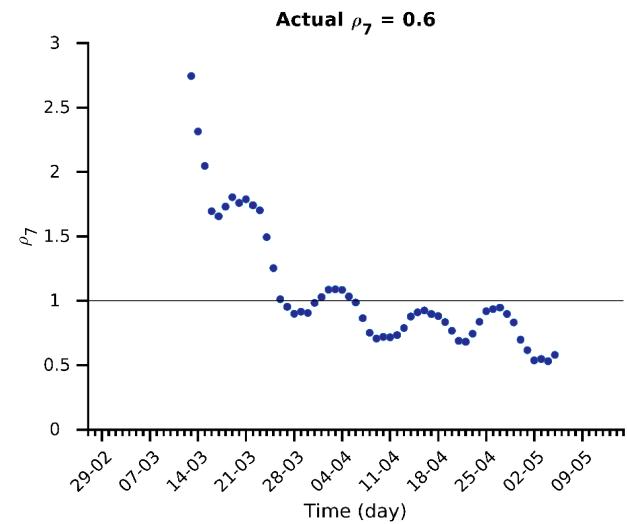
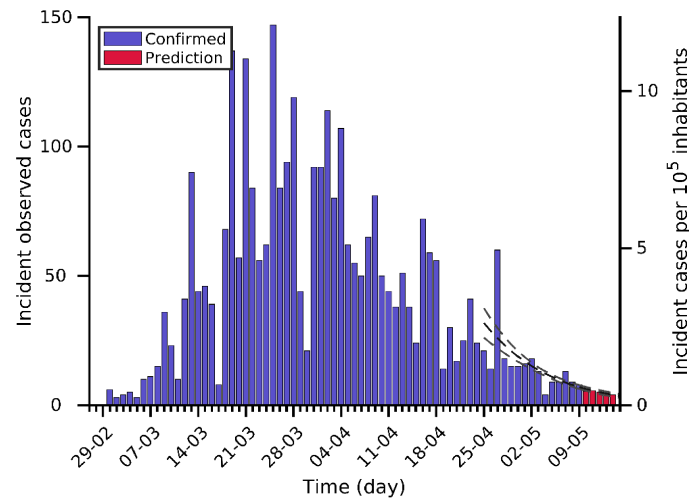
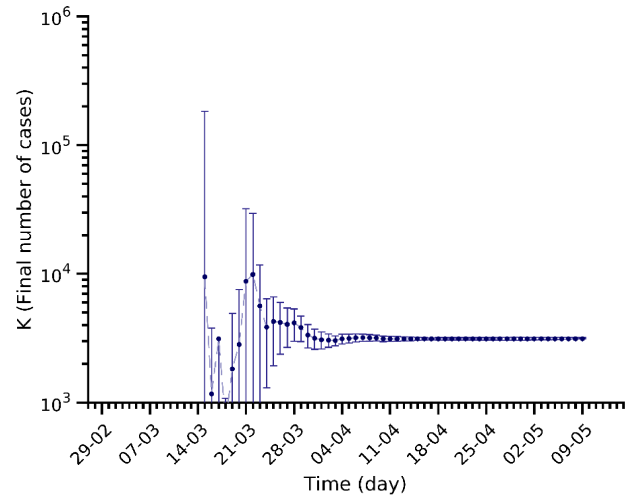
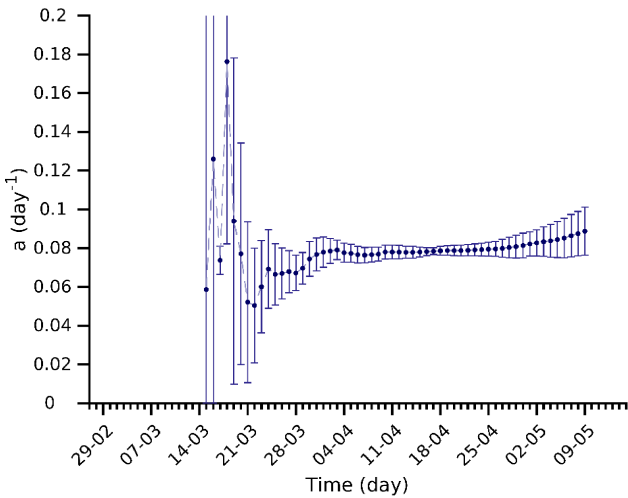
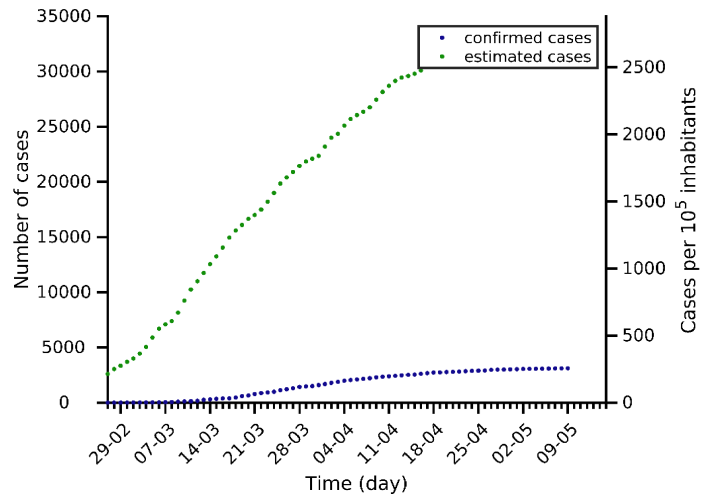
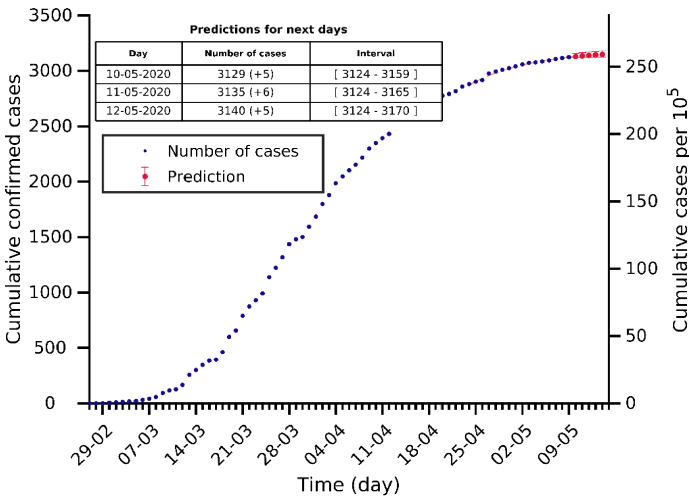
# Puglia 09-05-2020. Population: 4.0M. Current cumulated incidence: 106/10<sup>5</sup>



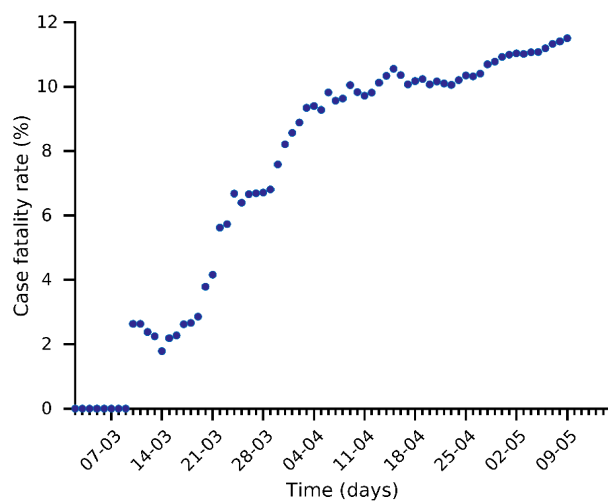
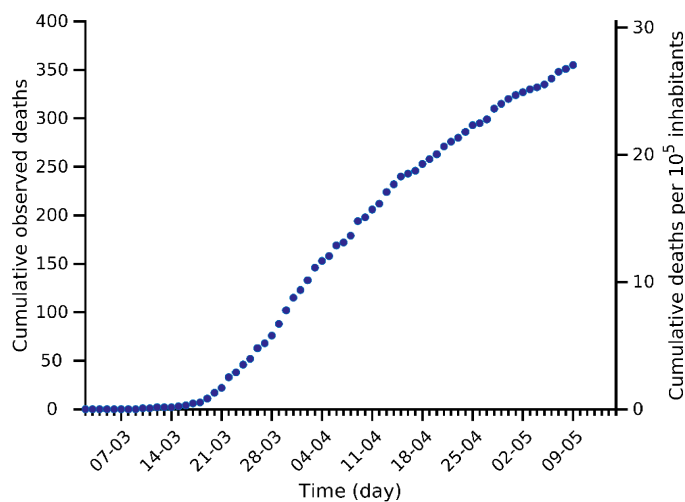
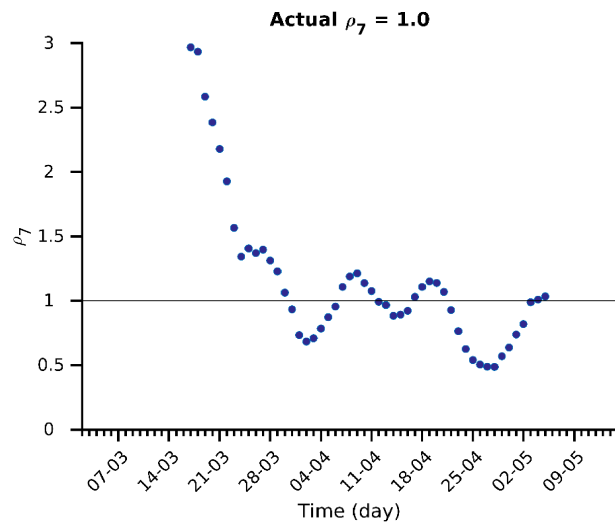
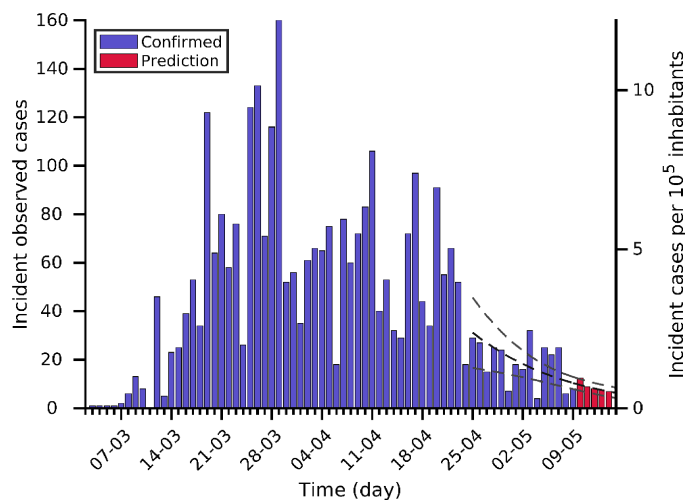
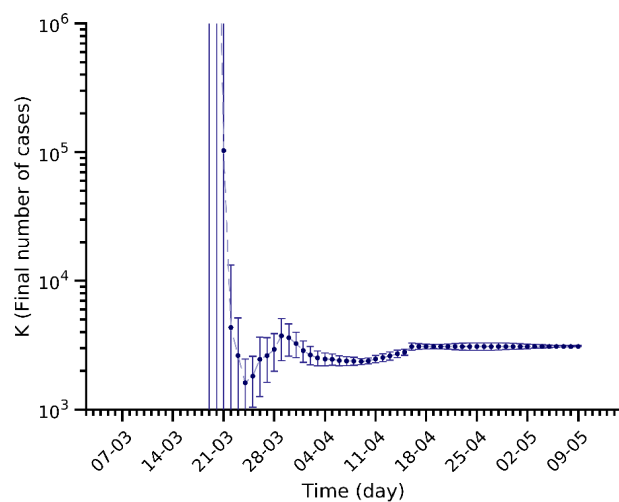
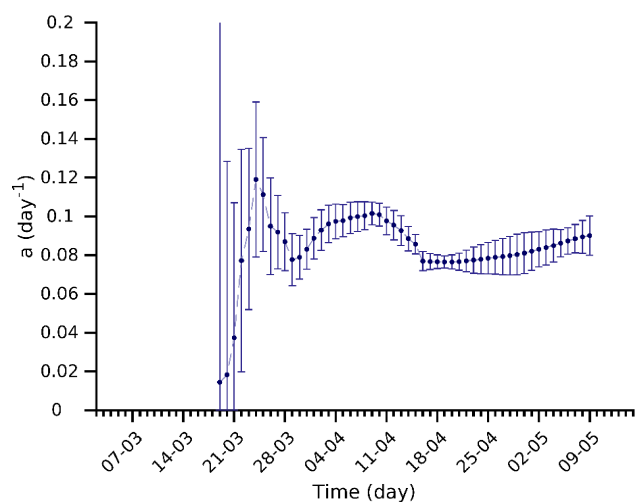
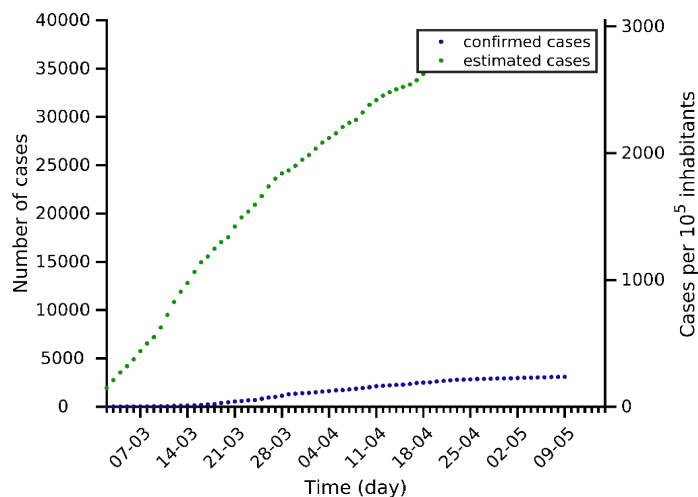
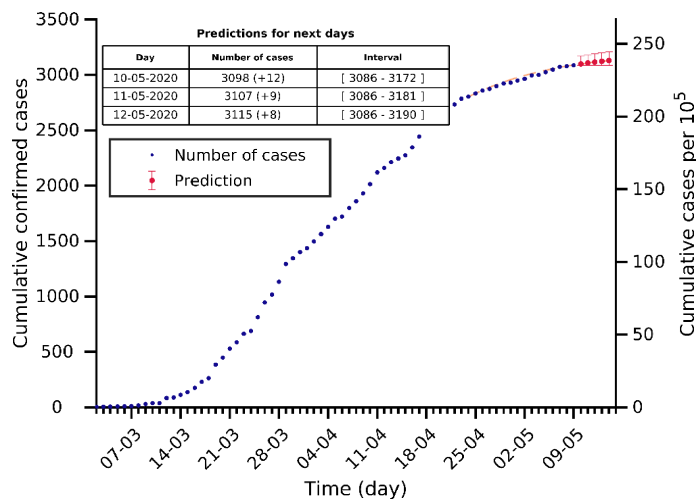
# Sicilia 09-05-2020. Population: 5.0M. Current cumulated incidence: 66/10<sup>5</sup>

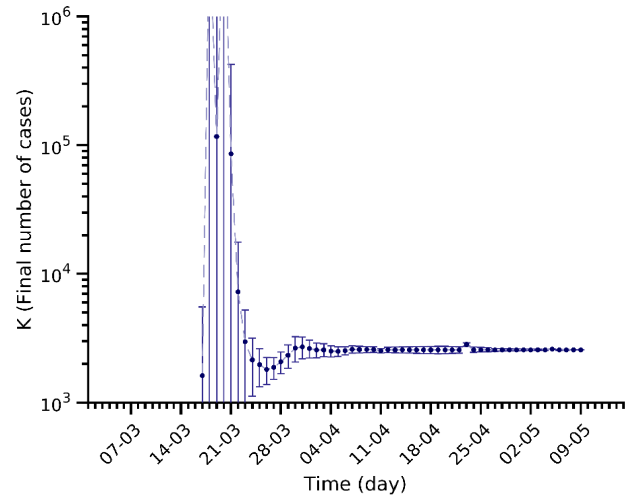
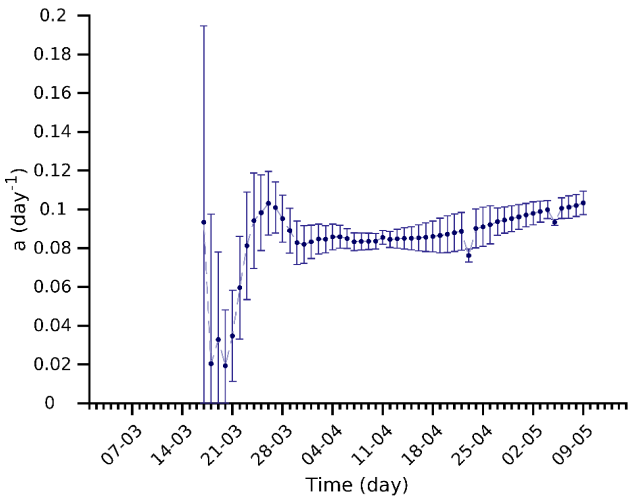
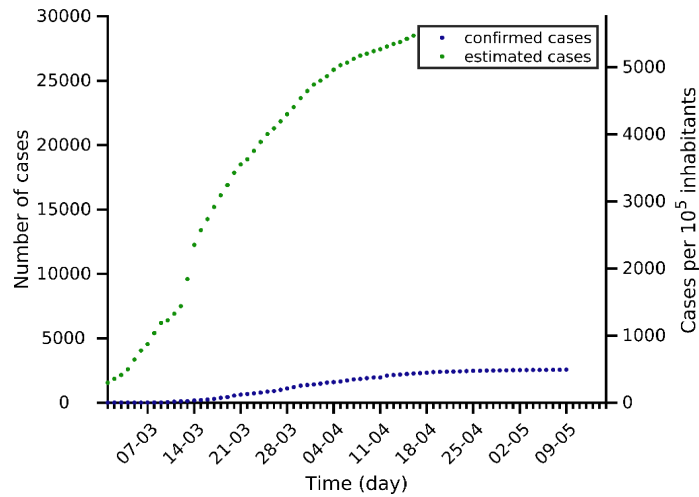
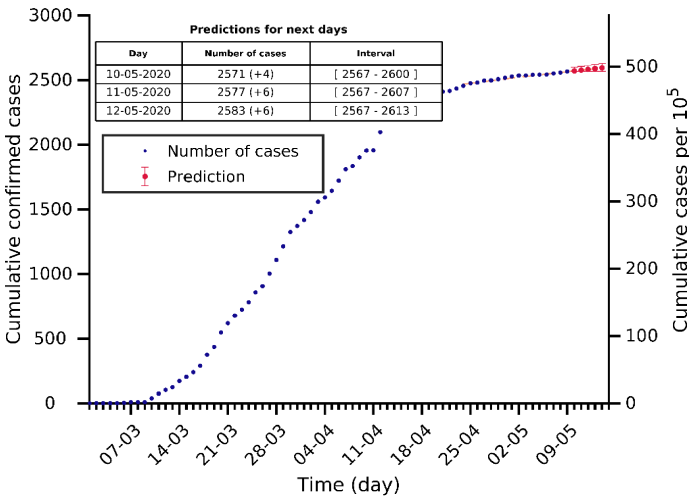


Friuli Venezia Giulia 09-05-2020. Population: 1.2M. Current cumulated incidence: 2

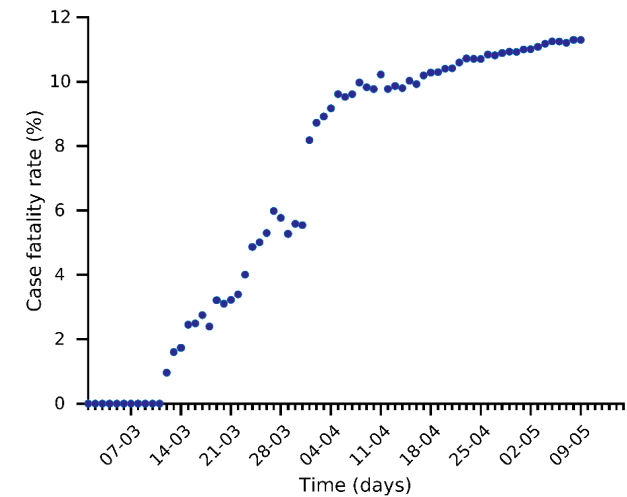
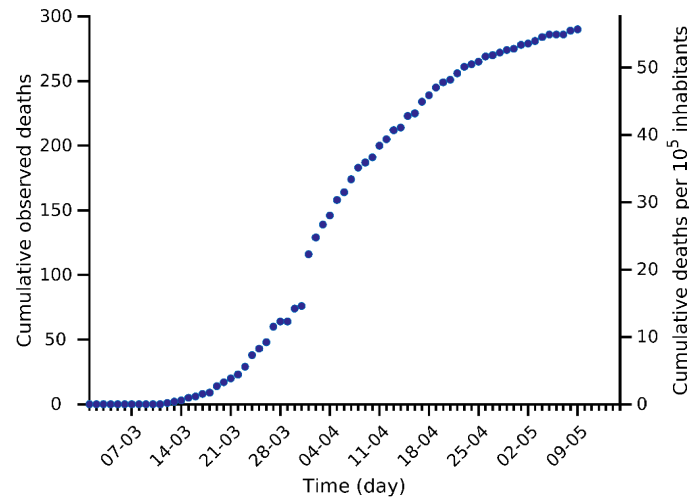
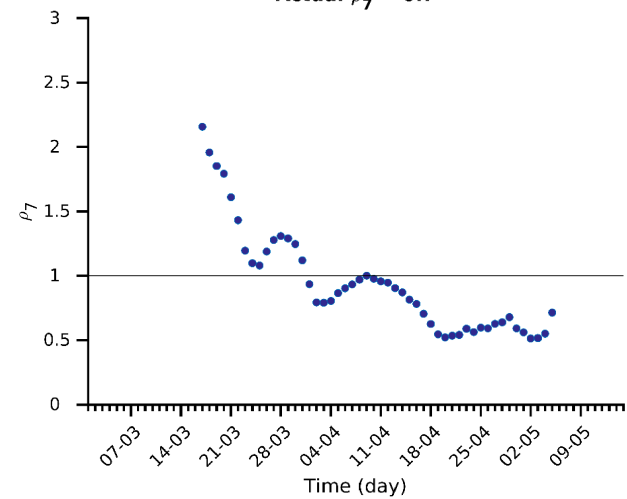
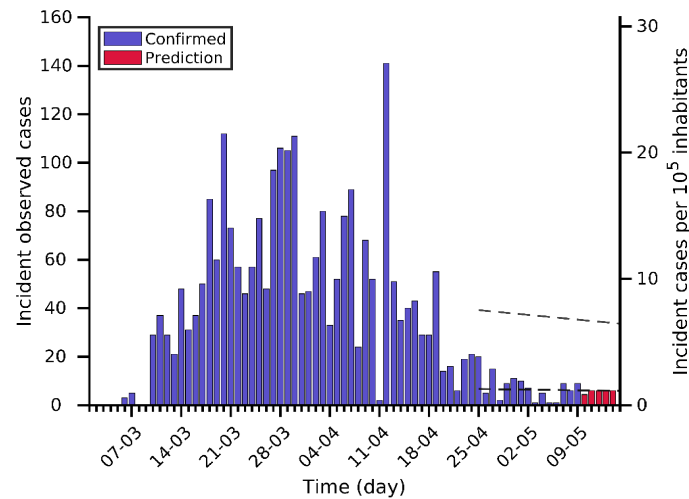


# Abruzzo 09-05-2020. Population: 1.3M. Current cumulated incidence: 235/10<sup>5</sup>

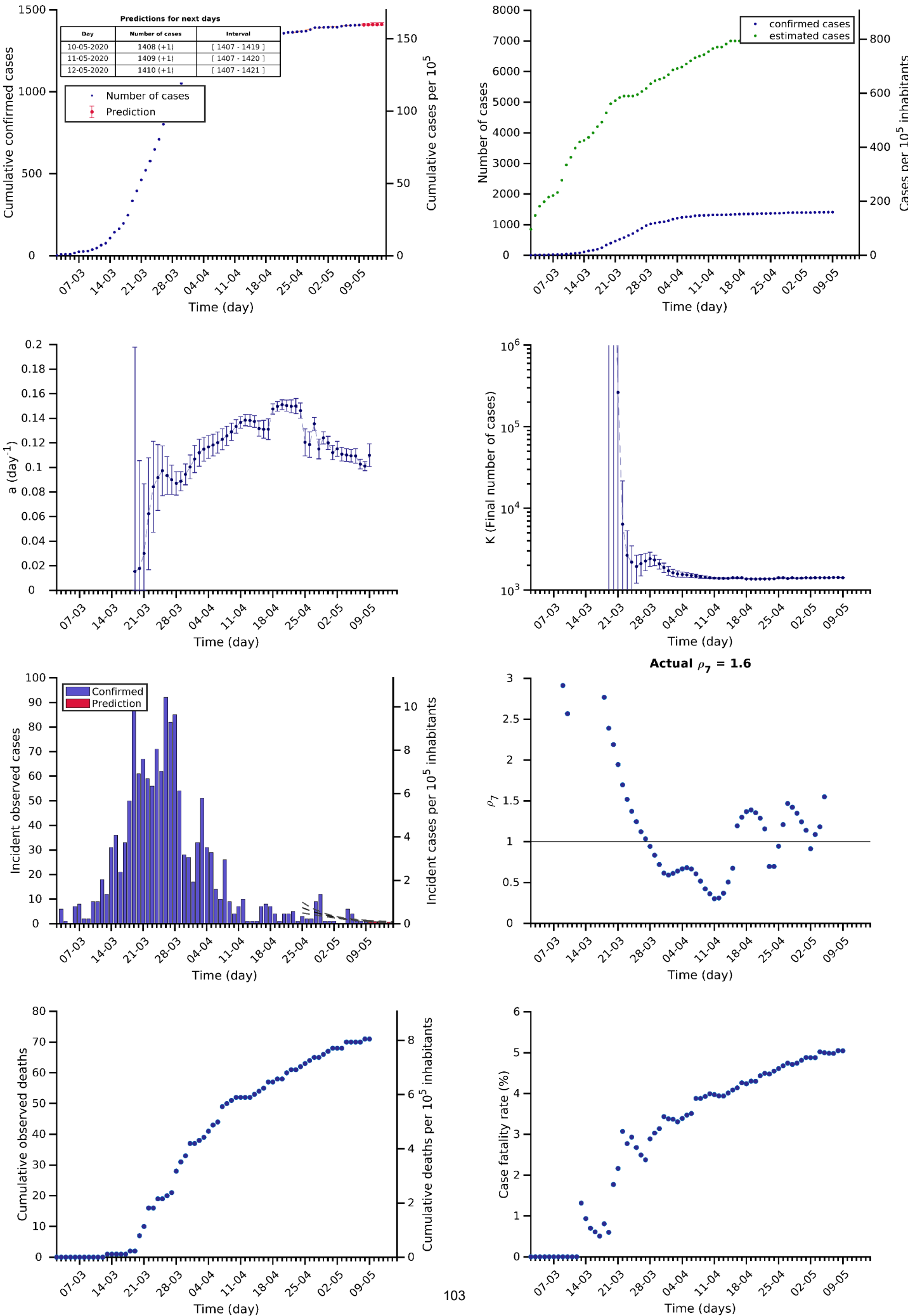




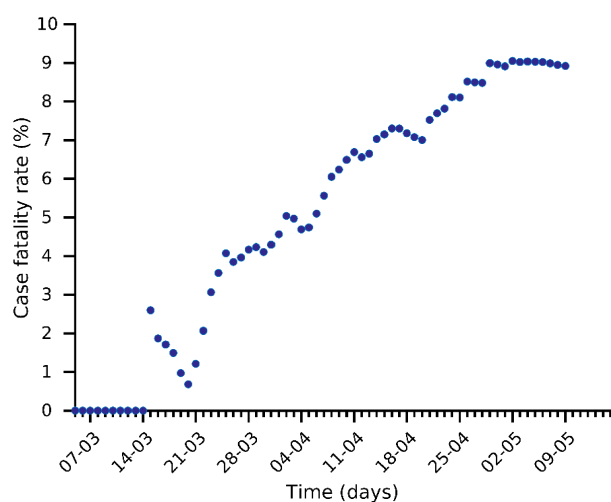
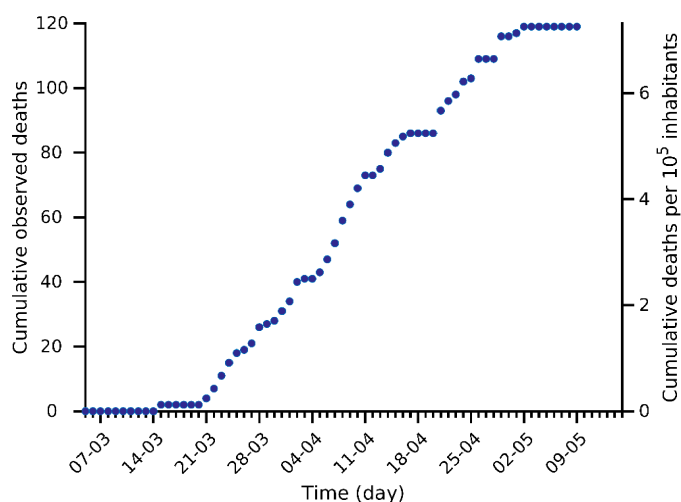
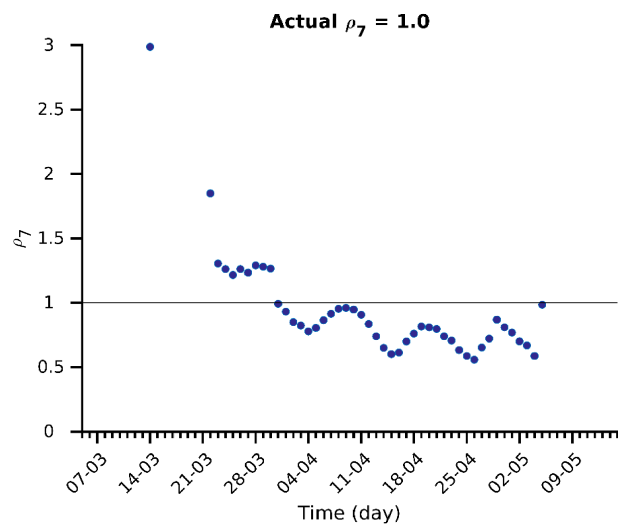
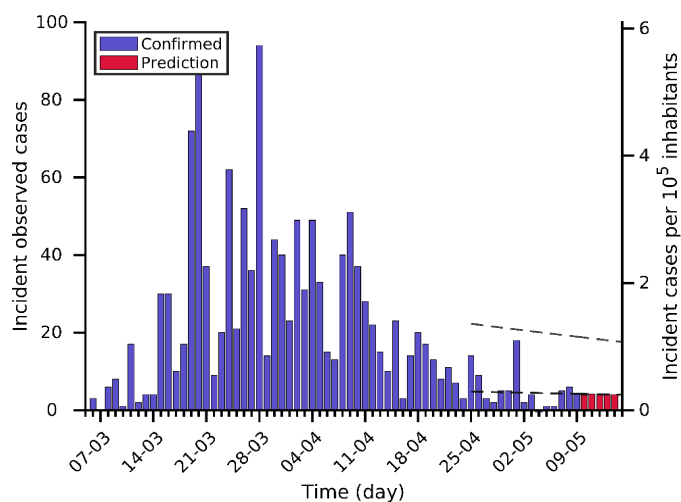
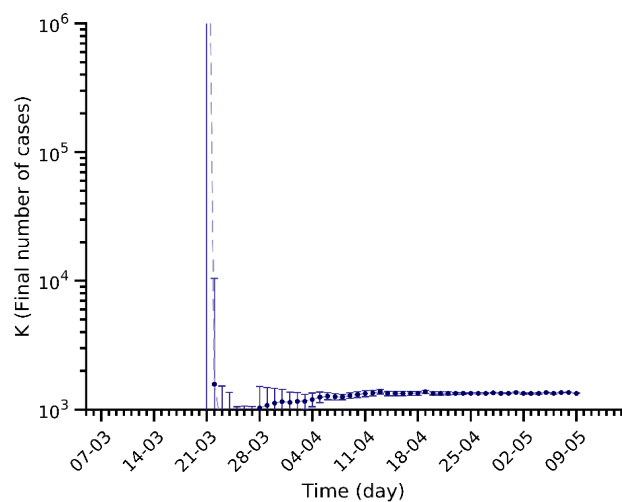
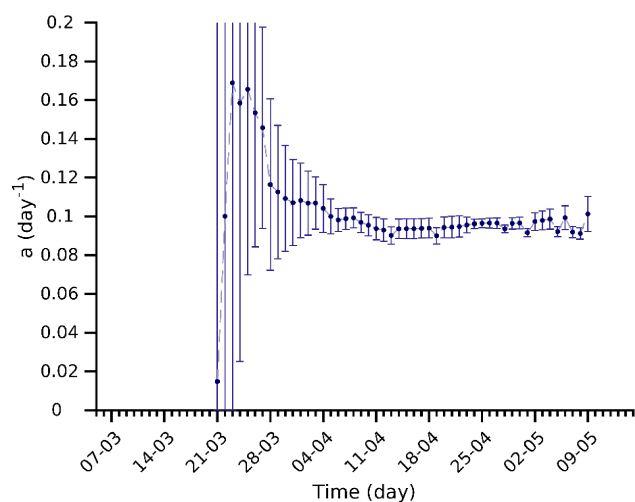
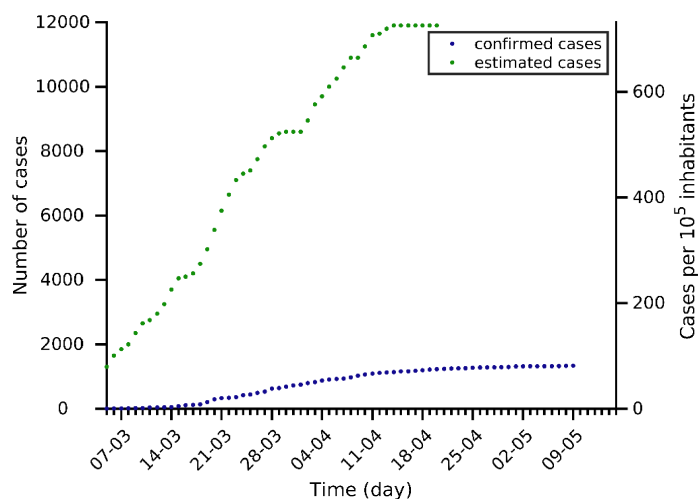
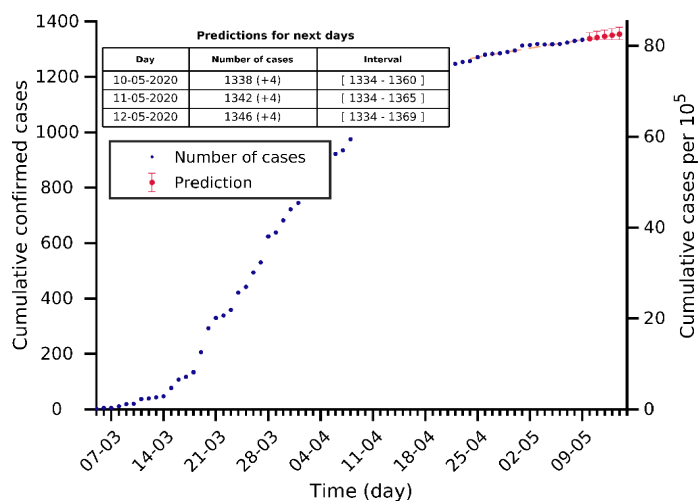
Actual  $\rho_7 = 0.7$



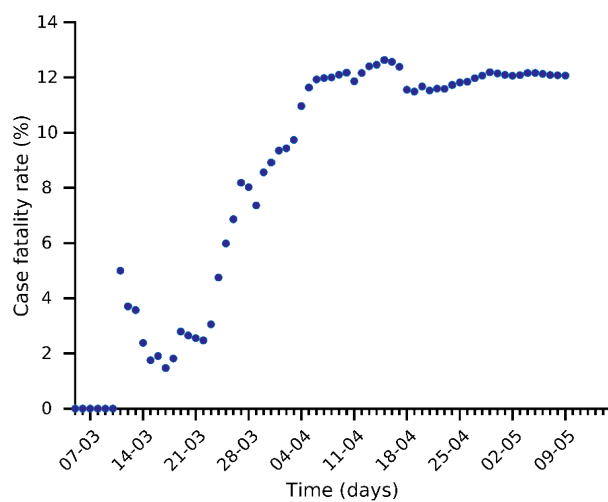
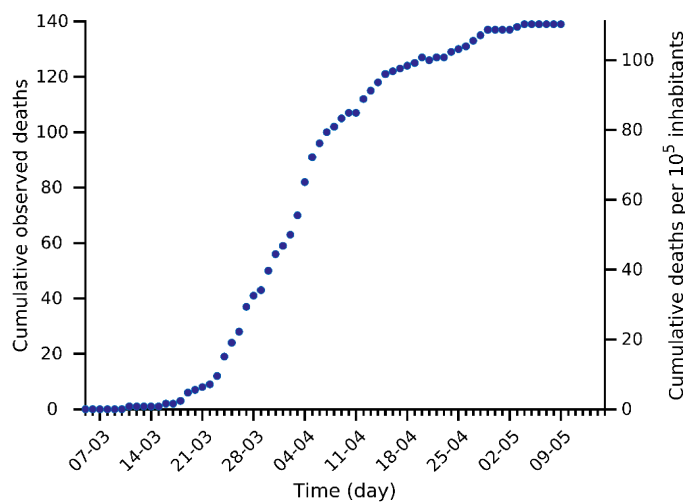
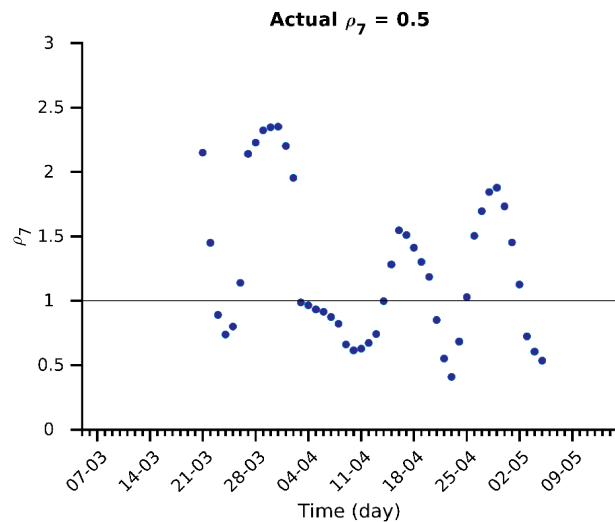
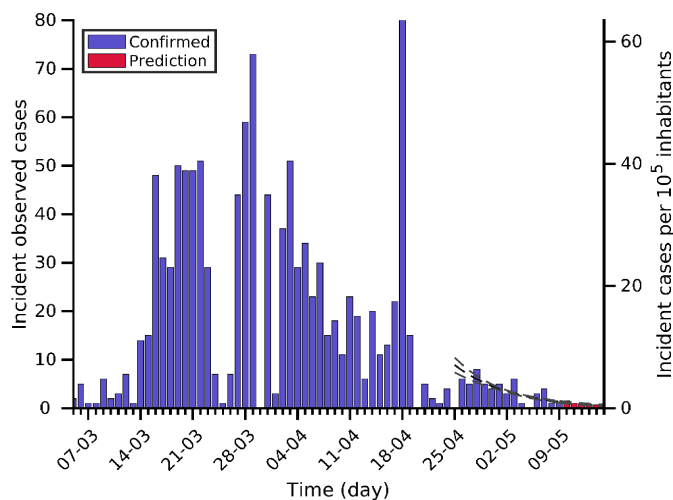
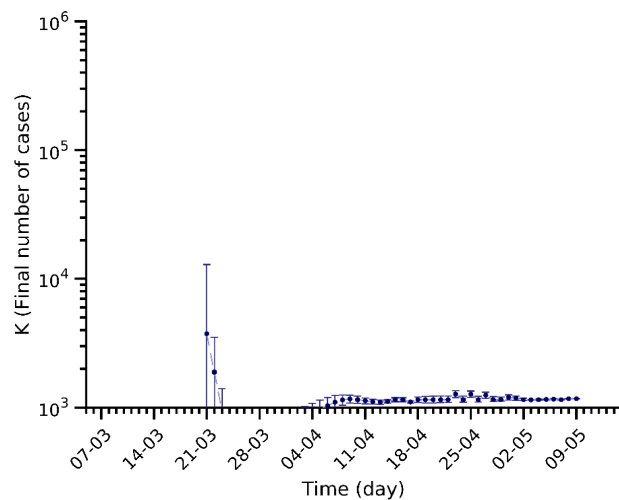
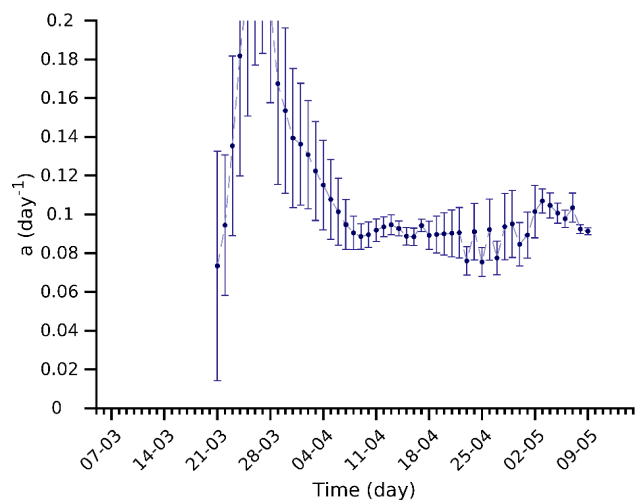
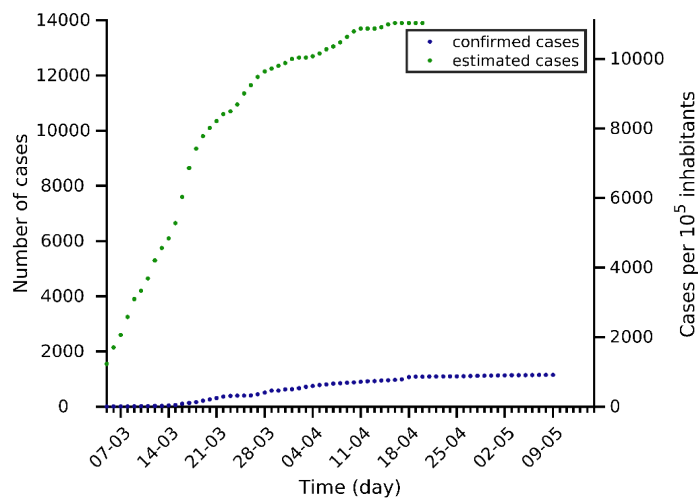
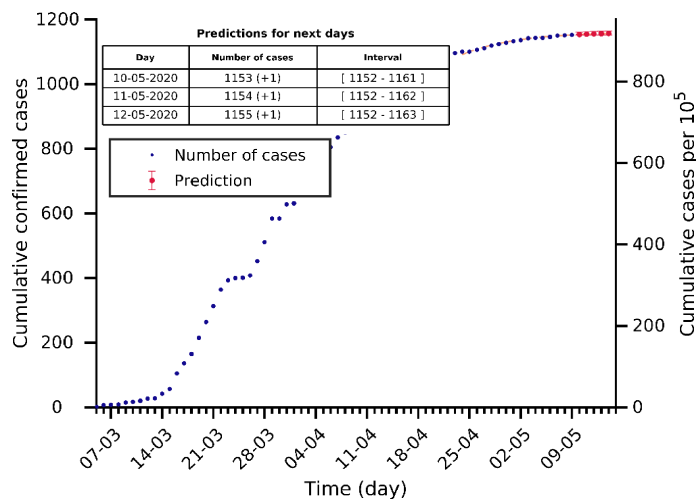
Umbria 09-05-2020. Population: 0.9M. Current cumulated incidence: 160/10<sup>5</sup>



# Sardegna 09-05-2020. Population: 1.6M. Current cumulated incidence: 81/10<sup>5</sup>

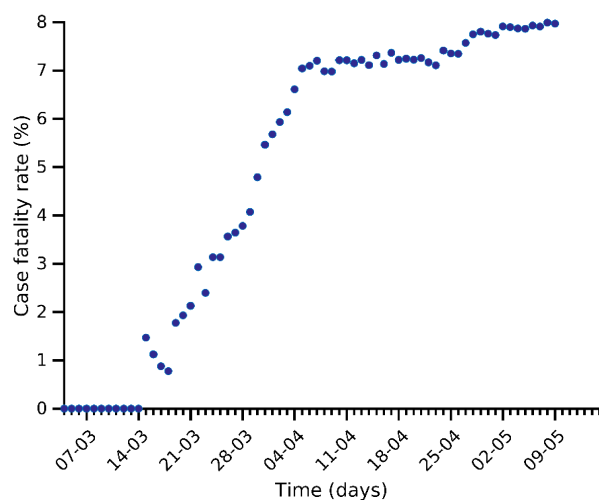
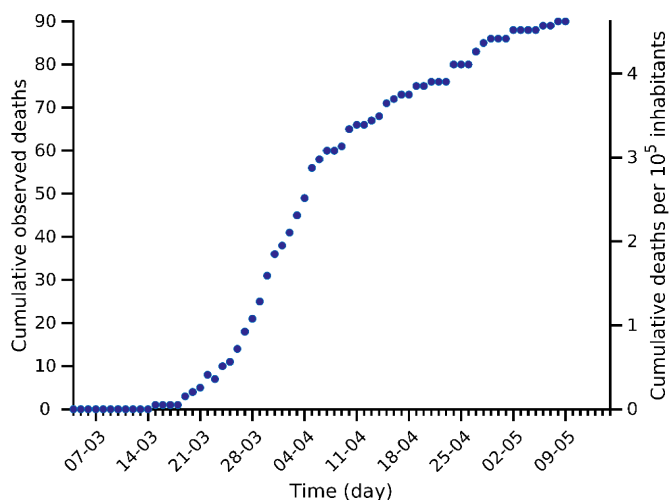
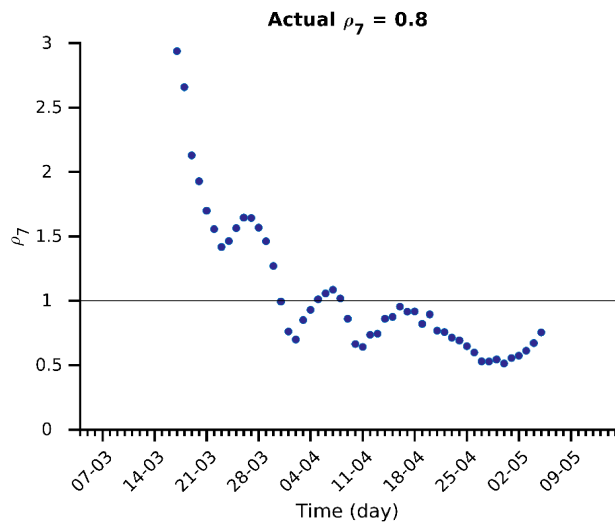
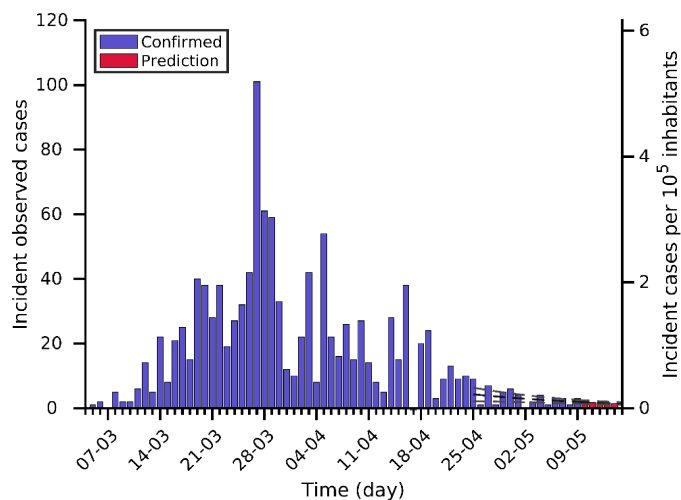
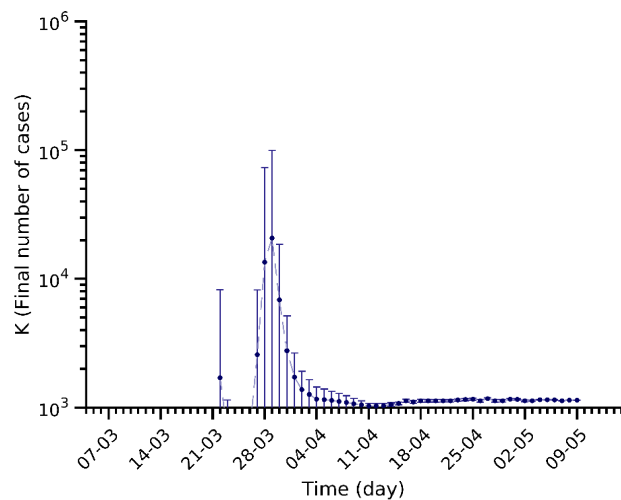
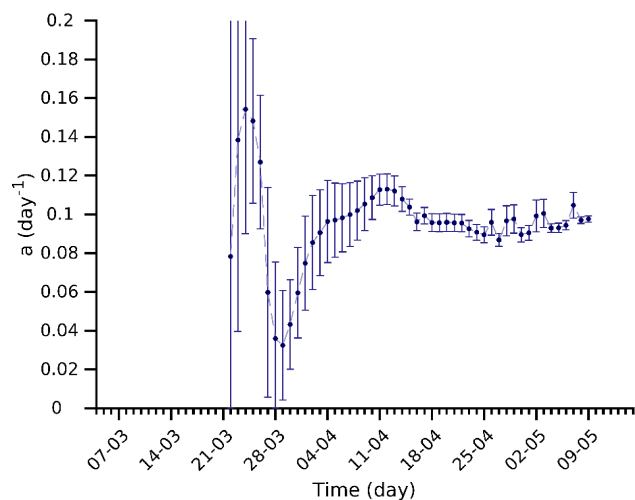
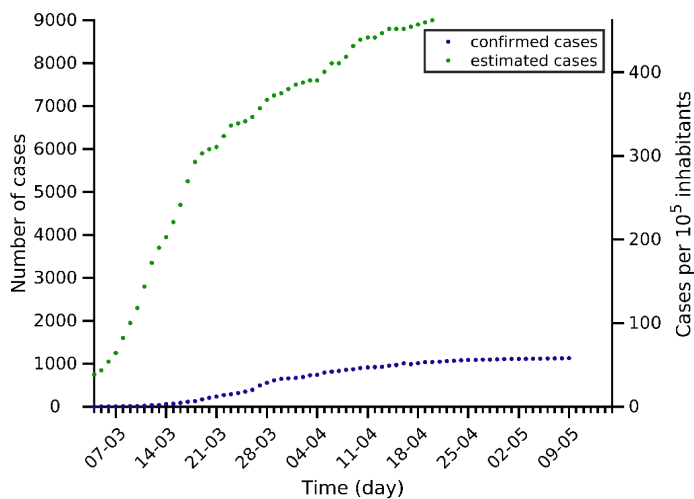
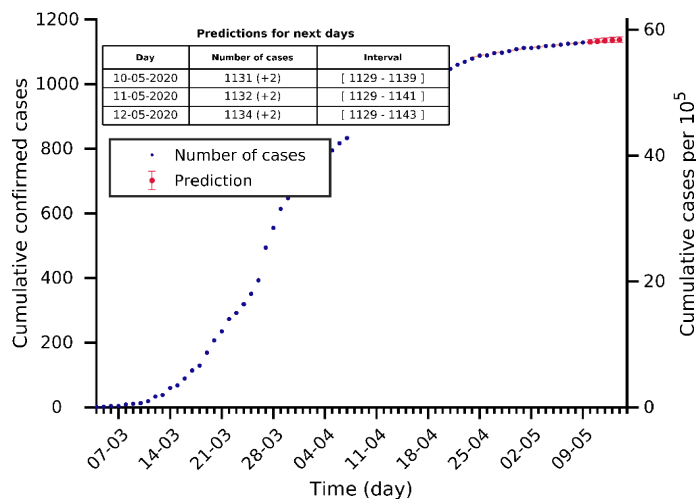


# Valle d'Aosta 09-05-2020. Population: 0.1M. Current cumulated incidence: 914/10<sup>5</sup>

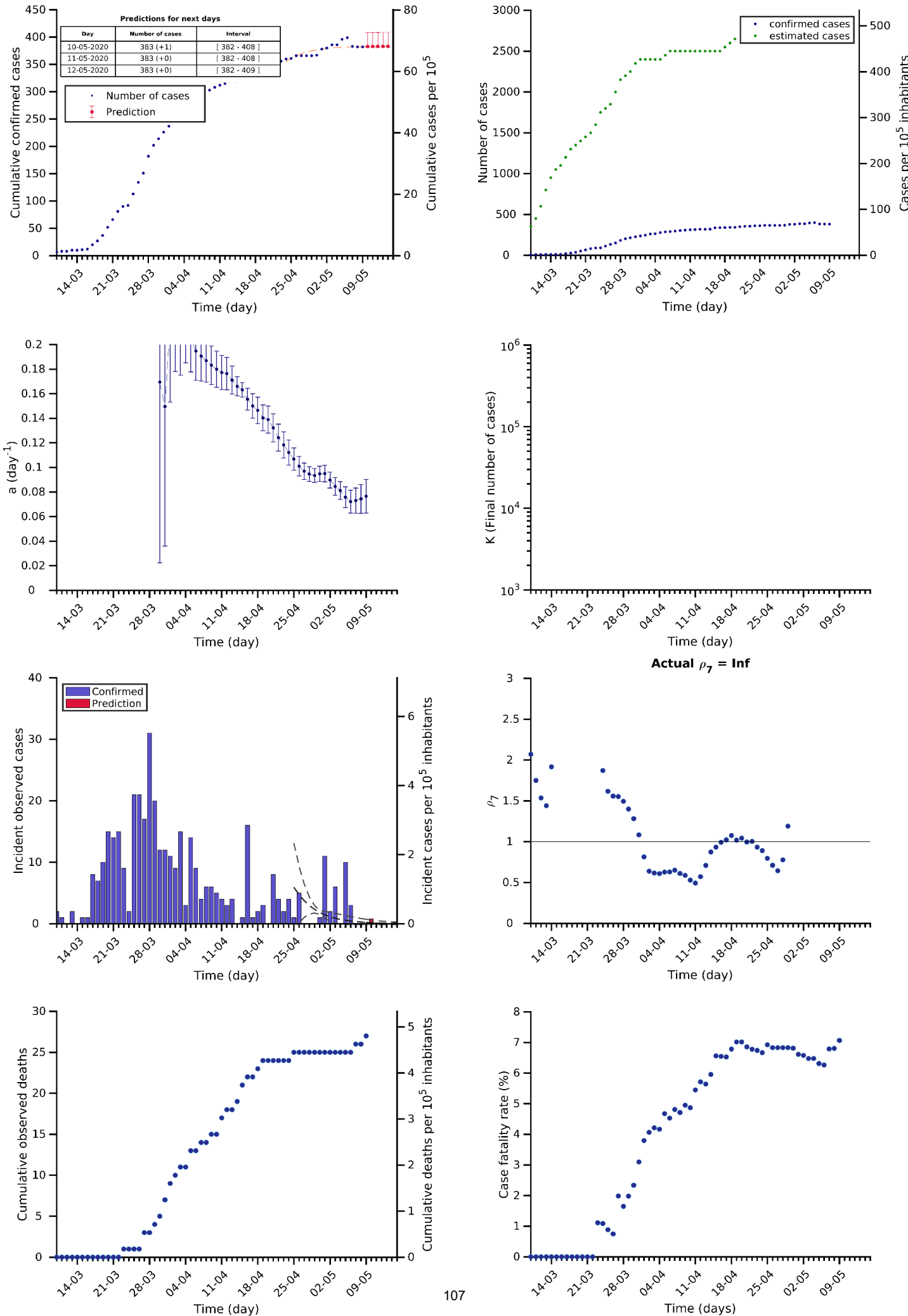




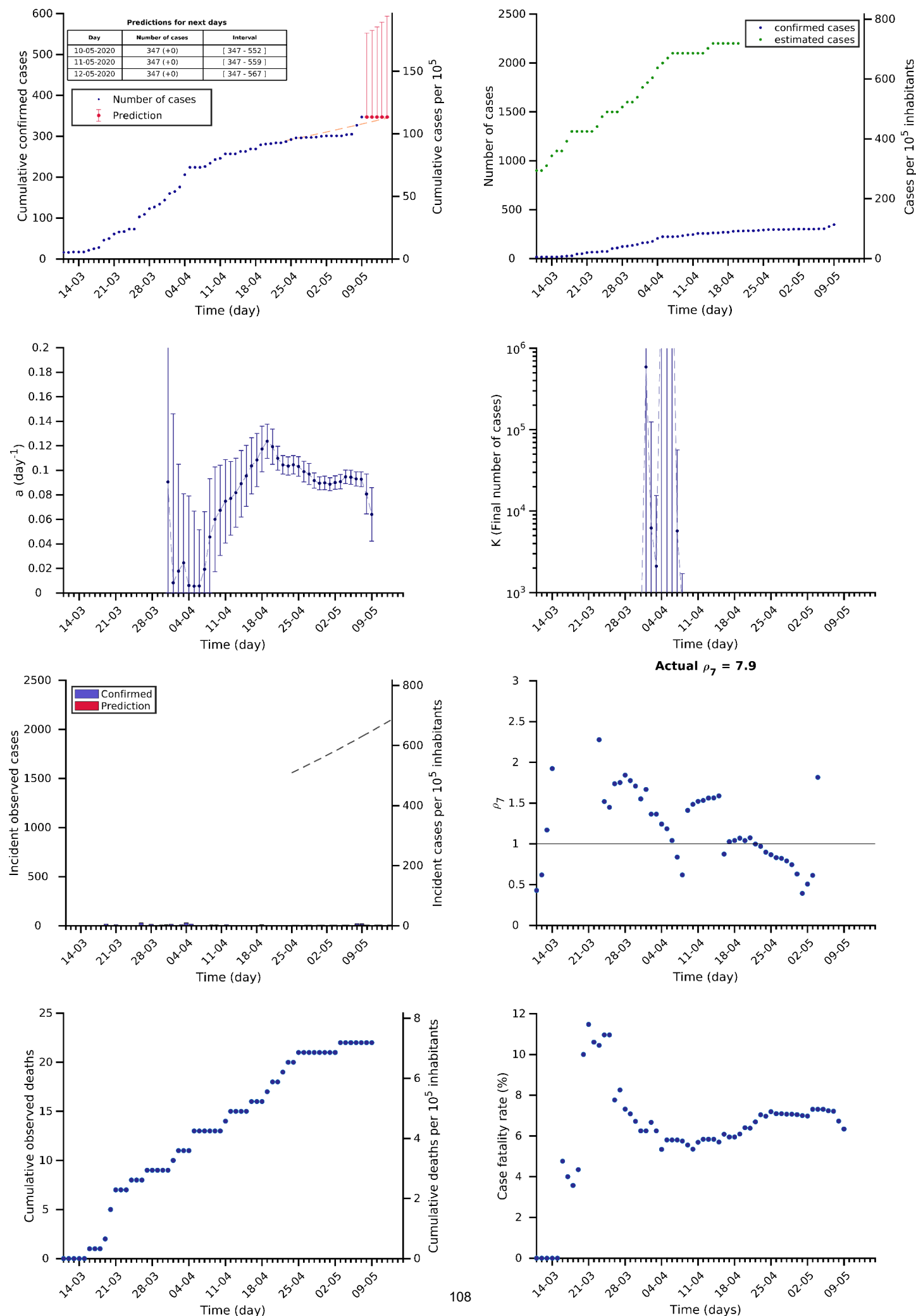
# Calabria 09-05-2020. Population: 1.9M. Current cumulated incidence: 58/10<sup>5</sup>



Basilicata 09-05-2020. Population: 0.6M. Current cumulated incidence: 68/10<sup>5</sup>



# Molise 09-05-2020. Population: 0.3M. Current cumulated incidence: 113/10<sup>5</sup>



## Methods

## Methods

### **(1) Data source**

Data are daily obtained from World Health Organization (WHO) surveillance reports<sup>1</sup>, from European Centre for Disease Prevention and Control (ECDC)<sup>2</sup> and from Ministerio de Sanidad<sup>3</sup>. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

### **(2) Data processing and plotting**

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓  $\rho$ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ( $t-1$ ):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where  $N_{new}(t)$  is the number of new confirmed cases at day  $t$ .

### **(3) Classification of countries according to their status in the epidemic cycle**

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

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<sup>1</sup> <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

<sup>2</sup> <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

<sup>3</sup> <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>  
<https://github.com/datadista/datasets/tree/master/COVID%2019> , <https://covid19.isciii.es/>

#### **(4) Fitting a mathematical model to data**

Previous studies have shown that Gompertz model<sup>4</sup> correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-a \cdot (t-t_0)}}$$

where  $N(t)$  is the cumulated number of confirmed cases at  $t$  (in days), and  $N_0$  is the number of cumulated cases the day at day  $t_0$ . The model has two parameters:

- ✓  $a$  is the velocity at which specific spreading rate is slowing down;
- ✓  $K$  is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day  $t_0$  is chosen as that one at which  $N(t)$  overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters ( $a$  and  $K$ ) and the  $R^2$  of the fitting. At the initial stages the dynamics is exponential and  $K$  cannot be correctly evaluated. In fact, at this stage the most relevant parameter is  $a$ . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted  $a$  with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted  $K$  with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if  $a > 0.2 \text{ day}^{-1}$ , if  $K > 10^6$  or if the error in  $K$  overpasses  $10^6$ .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

#### **(5) Using the model for predicting short-term tendencies**

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

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<sup>4</sup> Madden LV. Quantification of disease progression. Protection Ecology 1980; 2: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days<sup>5</sup>;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

### ***(6) Estimating non-diagnosed cases***

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors<sup>6</sup> in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

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<sup>5</sup> At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

<sup>6</sup> Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3